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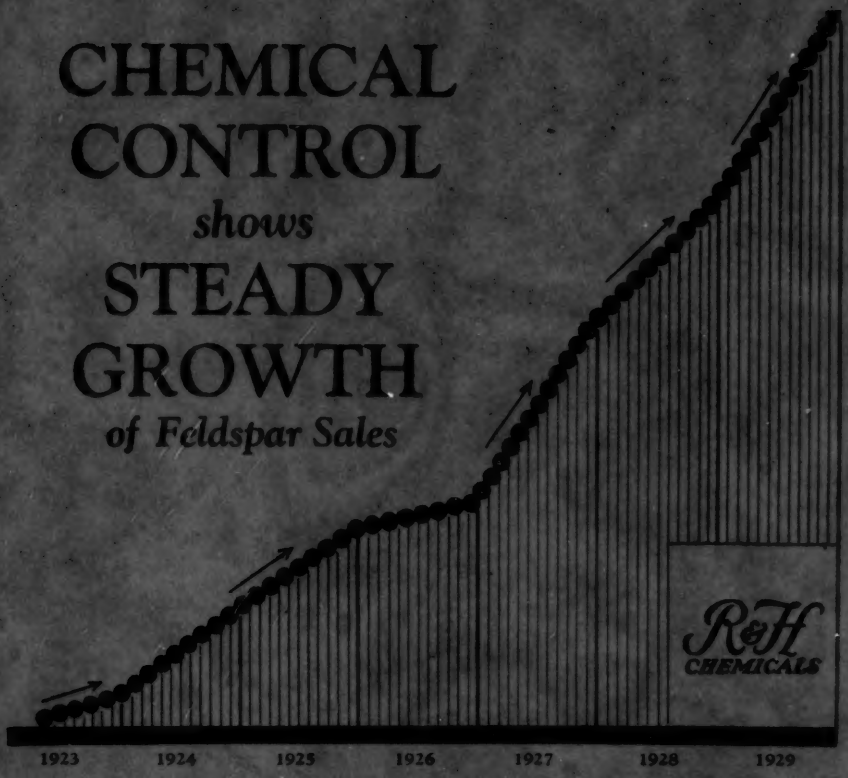

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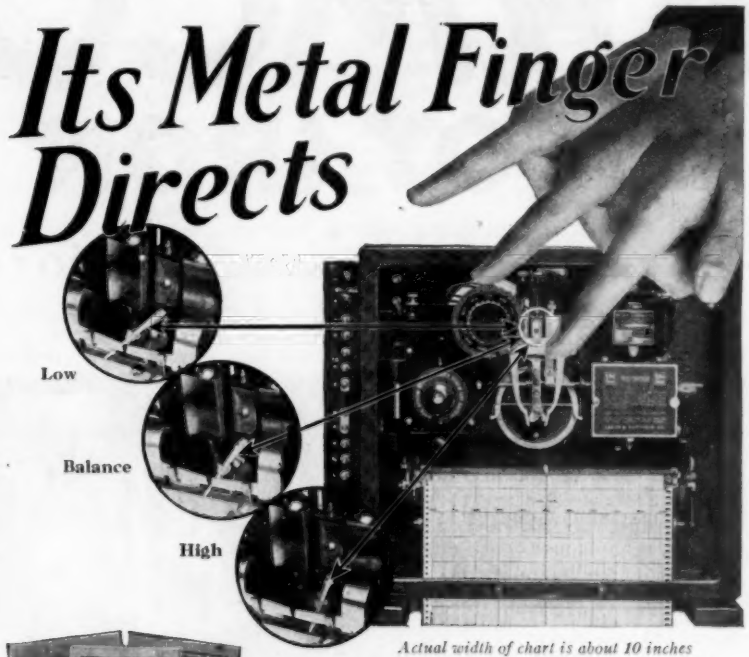

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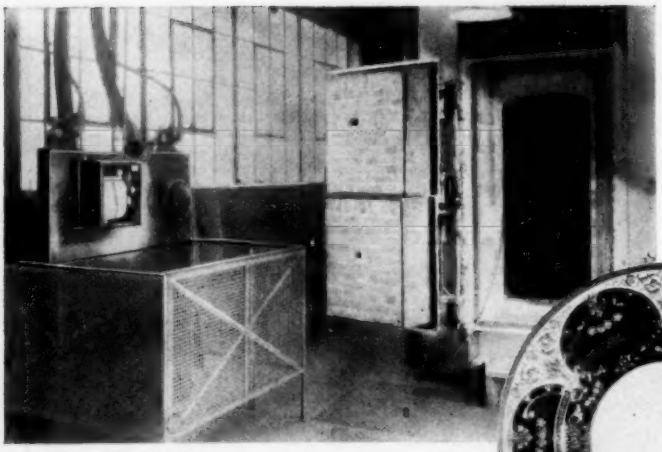

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GYPSUM PLASTER IN THE CERAMIC INDUSTRIES[1]

By J. E. Wiss, T. P. Camp, and R. B. Ladoo[2]

ABSTRACT

This paper deals with manufacture, properties, and uses of gypsum plaster in the various branches of the pottery industry, *i.e.*, in white ware, stoneware, electric insulators, sanitary ware, etc., in the terra cotta industries, in plate glass, and for sundry minor ceramic uses.

The methods of producing calcined gypsum are briefly described and then follows a discussion of the physical and chemical properties of the three principal forms of calcium sulphate as used commercially, (1) crude gypsum, (2) calcined gypsum (gypsum plaster), and (3) gypsum casts of set-up gypsum plaster.

The proper methods of mixing, blending, and casting plaster are described, with graphs showing effects of varying such factors as consistency, mixing time, etc. Methods of testing plasters are briefly discussed. Considerable attention is given to difficulties commonly encountered in the use of plaster, with causes and methods of correction. This includes the use and abuse of plaster molds, such as "rotting" of molds, "burning" of molds, efflorescence, etc.

The properties of gypsum plaster can be varied within wide limits to meet special requirements. It is shown how the plasters used for pottery and terra cotta molds are quite different from those used in bedding plate glass.

The purpose of the paper is to give a more complete picture of how gypsum plaster may and should be used in the ceramic industries.

I. Introduction

Plaster, for a number of years, has been the principal material used in the forming and shaping of ceramic products. The finished products themselves do not contain plaster, since it serves only as an intermediate between the original model or pattern and the reproduction in clay. It has come to this position because of its economy, its adaptability, and because of the peculiar properties inherent in castings made from it. The raw material used in the preparation of plaster is gypsum. This is a naturally occurring rock found in many places in beds of varying purity. The rock itself contains about 20% of chemically combined water. When this rock is powdered and heated, it loses approximately three-fourths of this water and becomes plaster, commonly called "calcined gypsum" or plaster of Paris. When this calcined gypsum is again mixed with water, it becomes a plastic or fluid mass, which can be cast or shaped at will, and which subsequently hardens back to gypsum by the replacement of the water of crystallization which was driven out in calcination. The value of the resultant casting to the ceramic industry generally lies in the fact that it differs from the natural mineral in that the porosity or the

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division). Received January 28, 1930.

[2] United States Gypsum Co. Canadian Gypsum Co., Ltd.

absorbent character, as well as the strength, can be varied to suit the will of the user.

II. Gypsum

As with a great number of other minerals, gypsum does not usually occur in nature in the theoretically pure state. As commercially obtained, the purity of the rock may vary from as low as 65% to over 99%, the impurities consisting of insoluble materials, such as limestone and silica or shale. Material taken from these deposits will naturally show variations in purity from day to day. For this reason, it has been customary to select only the purer deposits of gypsum rock as sources of plaster for ceramic use. Typical of these purer deposits are the deposits to be found in places in Nova Scotia, in Oklahoma, and in Kansas, which run higher than 99% pure gypsum.

Gypsum is one of the two common forms in which the salt, calcium sulphate, occurs in nature. The other natural form is the mineral anhydrite. This latter mineral differs from gypsum in that it contains no chemically combined water and therefore cannot be used as a base in the preparation of plaster without chemical treatment. Both these minerals are stable at ordinary temperatures and pressure. Gypsum, however, is unstable at higher temperatures and may be partially or completely dehydrated in such a way that the resultant product will again combine with water when in contact with it at ordinary temperatures, and will revert back to gypsum. The products of calcination of gypsum rock, which possess this ability to revert back to gypsum when wetted, are called "calcined gypsum" or "plaster of Paris." Their chemical composition, in the absence of free water, is $2CaSO_4 \cdot H_2O$, the so-called hemihydrate. It is never found naturally as a mineral.

III. Calcined Gypsum or Plaster

In the preparation of plaster from gypsum rock for ceramic uses, the rock is ground to a fine powder with suitable milling machinery. This fine powder is heated in large cylindrical kettles equipped with agitators. The heating is controlled accurately and is continued until a sufficient amount of water has been driven out of the gypsum rock. This water that is removed is not visible as water either in the gypsum or in the finished product, being all chemically combined. Maximum calcination temperatures reached in the calcining cycle range from 300 to 400°F.

In the older methods of plaster manufacture in this country and in methods now in use in some European countries, the gypsum rock is heated until all of the combined water has been driven out and the resulting plaster has the chemical formula $CaSO_4$ with no water of crystallization. This type of plaster, the so-called "second settle" plaster, possesses the peculiar

property of rapidly absorbing moisture from the air and reverting to the hemihydrate. Until it has aged out to the hemihydrate, it possesses the property of combining immediately with water to form the hemihydrate when it is mixed with water, with a marked increase in temperature. Gypsum which has been heated to a red heat to remove all of the water of crystallization becomes inert in water, although by the addition of various electrolytes it may again be caused to crystallize back to gypsum. Gypsum treated in this way is not called calcined gypsum, but is called "burned" or "dead burned" gypsum and forms the basis of Keene's cement, Parian cement, and the hydraulic gypsums which have been used extensively in Europe. They have as yet found no application in the ceramic industry.

Ordinary calcined gypsum, when freshly manufactured and ground to a fineness which gives gypsum castings a texture suitable for ceramic work, requires a relatively large amount of water in mixing and does not mix readily. When it is allowed to age from one to four months in ordinary storage, the mixing character improves and the mixing water requirements decrease, although there is no apparent change in the fineness. This change in storage is called "aging," and was formerly necessary in order to produce castings of high strength and uniform texture. This aging may be accomplished by suitable chemical treatment during calcination. One of the methods of accomplishing it is called "aridizing," a patented process in which a small amount of a deliquescent salt is intimately mixed with the gypsum. This addition causes rapid aging, reduces the water-carrying capacity, and improves the workability of the plaster. Processes of this kind eliminate the need for long storage before use, and permit manufacturing control of consistency.

Calcined gypsum possesses the capacity to absorb water slowly out of the atmosphere. As this water is absorbed it combines chemically with the calcined gypsum. Under ordinary storage conditions, this slow absorption may go on for from eight to twelve months before it has any deleterious effect on the plaster. The gypsum contamination, gradually formed, causes an accelerated set, raises the water-carrying capacity, and weakens the casting. Since it is inert, it acts as so much filler which also reduces the strength of the final casting. It is for this reason that plaster storage should be away from damp floors, heavy currents of air or steam, and should not be located where dripping condensation from roofs or overhead piping can get to it. It is also for this reason that proper rotation of plaster in storage in a ceramic plant must be practised. This rotation calls for the use of all old plaster before beginning on a new shipment. Plaster today is almost universally sacked in heavy multi-wall paper bags, which give far better protection to the plaster during storage than the jute bags formerly used.

IV. Ceramic Uses

The three most important branches of the ceramic industry requiring plaster are: (*A*) pottery manufacture: (1) white ware, (2) sanitary ware, (3) insulator, and (4) stoneware; (*B*) structural ceramic units: (1) terra cotta and (2) special refractory shapes; and (*C*) plate glass.

In the general pottery and terra cotta field, castings of plaster serve to shape the raw clay mixture, ranging from the rather dry or heavy mixtures used in "dust pressing" and terra cotta to thin slurries used in casting hollow white ware or dinnerware. In all of these uses the clay first comes into intimate contact with the plaster and receives its shape from the plaster mold. The absorption of water by the plaster subsequently fixes the shape of the clay and strengthens it by removing free water from it to a point where it can be handled without breakage or distortion. In addition, in terra cotta manufacture, plaster serves as the intermediate plastic between the artist's clay sculpturing of the ornamental work desired and the reproduction of it in plaster. This plaster reproduction in turn serves as the model around which is cast in plaster a sectional mold, which is subsequently reassembled away from the model and serves as a receptacle and a shaping mold for the terra cotta clay.

In plate glass manufacture, calcined gypsum has an entirely different function. In this industry it also serves as an intermediate. Its prime function is the formation of a perfectly level bed and the cementing of the plate glass to this bed while it is being ground and polished. The property of absorption, so desirable in the pottery and terra cotta field, is of minor importance in plate glass plaster. The property of slight but positive expansion, which permits plaster castings to be removed from plaster molds, and which gives plaster castings their fine, clean definition, is also not wanted in plate glass practice. The need for smooth, bubble-free texture, so important in securing long life from a ceramic ware mold, also is not important in the plate glass polishing process. For this use a plaster is required which mixes with water with extreme ease, and in which there is no impurity which will scratch glass. In addition, the plaster must be of such nature that, after it is mixed with water, the water which is not required in holding it together can be readily removed by using dry plaster as an absorbent. In this way water can be pulled from the plaster under a plate of glass and the strength of the bed enormously increased. In addition to its ability to spread out as a liquid and to be forced into a level bed by the laying of the glass, the plaster used in plate glass practice must possess an expansion, during setting, so small that the set plaster remains in almost molecular contact with the glass while it is being polished. This extremely close contact, which may or may not bring in a secondary effect of surface chemical reaction, is brought about by the use of hydrated lime. This, when mixed in proper quantities with the plaster, reduces

the expansion during setting to a negligible amount. The bond of the bedded glass to the plaster seems to be due to this extremely intimate contact, which remains unbroken during the setting stage.

From the above general discussion, it will be recognized that in the manufacture and use of calcined gypsum we are dealing with three different physical and chemical states. These are as follows:

(A) The mineral gypsum (completely hydrated calcium sulphate $CaSO_4 \cdot 2H_2O$), the basis of all manufactured gypsum products.

(B) Calcined gypsum or plaster, a more or less finely divided powder obtained by grinding the natural mineral and heat-treating it to remove part of its chemically combined water, thereby changing its chemical and crystalline structure.

(C) Set plaster, the product resulting when calcined gypsum hardens after being mixed with water. It is composed of gypsum crystals, in intimate interlocking contact forming a hard mass, whose properties may be controlled. The characteristics of this last state and the effect of various manipulations on it as they pertain to ceramic use, form the basis of this paper.

V. Characteristics of Ceramic Plasters and Molds or Castings

A. Water-to-Plaster Ratio

The most vital factor affecting the quality of plaster castings made from calcined gypsum is the weight ratio between the plaster and the water used in mixing it. Variations in the amount of water affect the strength, the total absorption, the apparent expansion during setting, and the internal structure of the casting, which in turn cause variations in the rate of wear due to use, variations in the tendency to weaken when allowed to remain wet, variations in the tendency to soften when exposed to too high a temperature, and variations in the rate of absorption of water from the clay mix being used.

Plaster from a given package may be mixed with the minimum amount of water required to give a plastic mix and produce a cast which has a dry compressive strength of more than 2000 pounds per square inch. The same plaster may be mixed with large excesses of water, and may be subsequently dried after setting into a product which would serve satisfactorily as a blackboard crayon. The amount of water may be still further increased to the point where the finished product will never harden and will be merely a mass of gypsum crystals dispersed in water in a fluid con dition. Since it is of such vital importance, the effect of changing this ratio has been studied carefully. By reference to Fig. 1, showing the effect of changing this ratio, some idea may be gained as to its importance.

The cause of these variations in strength and absorption, with variations in the water used in mixing, can be readily understood when it is

remembered that, in addition to the water required chemically to transform a calcined gypsum into gypsum, excesses of water over and above this are necessary in order to give the mixture sufficient plasticity or fluidity, as the case may be, so that it may be shaped as a plastic or poured into molds as a fluid. On the completion of the setting process this excess water remains in the casting. When it is removed, by drying, the volume which it occupied is displaced by air. As the mixing water is varied this resultant air volume also varies. The total absorption of the plaster mold varies directly with it. As this "void volume" is increased the apparent

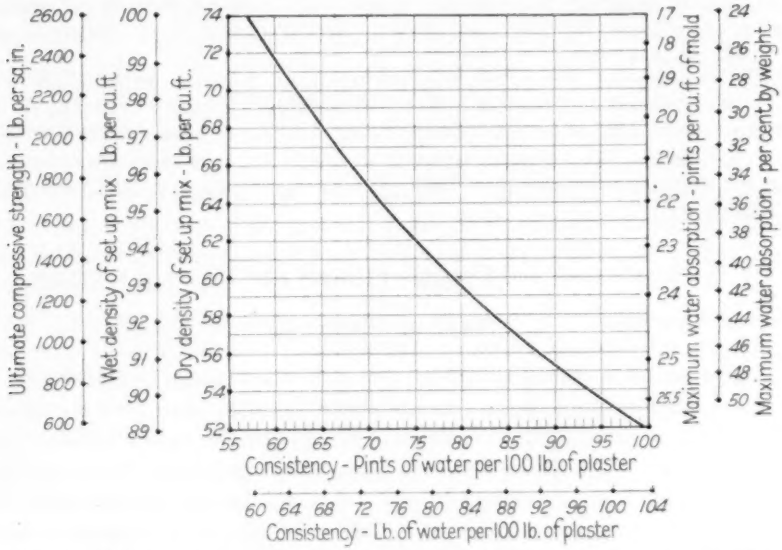

FIG. 1.—Effect of consistency on the wet and dry density, dry compressive strength, and water absorption of the dried cast.

density of the casting is decreased. The compressive and tensile strengths also decrease in proportion, since in any given section the number of gypsum crystals will be reduced in proportion. Likewise, when the number of gypsum crystals in any given section or on the surface of any mold is decreased by the use of more water, the active area of gypsum exposed will decrease and thus weaken the resistance of the casting to abrasion and to shock, and will increase the rate of wear of the plaster mold accordingly. When alkalis such as sodium carbonate or sodium silicate are used in the clay, the reaction which they undergo in contact with gypsum, also will cause a more rapid surface wear.

It is seldom possible to produce a workable mix of plaster and water using less than 60 pounds of water to each 100 pounds of plaster. Taking a mix of this type for example, 100 pounds of pure plaster will require

approximately 17.5 pounds of water chemically to set it completely. The mix resulting therefrom will therefore have approximately 42.5 pounds of free water in it when it has set. When the set casting is dried it will have voids in it corresponding to the volume of 42.5 pounds of water. Reference to Fig. 1 shows that a mix at this consistency has a compressive strength of 2500 pounds per square inch, a total absorption of 25%, expressed in weight percentage, and a dry density of 73.5 pounds per cu. ft. Mixes in common use in potteries seldom go below this figure.

This chart shows, and experience in a number of potteries and ceramic plants proves that the least amount of water used in a plaster mix, consistent with good clean castings, will give the longest life possible.

Control of the water-to-plaster ratio is positive only when measured amounts of water and weighed amounts of plaster are used in each batch or mix. This applies regardless of whether hand mixing or machine mixing is employed. It is a vitally important factor in the production of uniformly high quality molds or castings, though it is not fully appreciated by a large number of mold makers.

B. Effect of Mixing on Strength

When plaster is first mixed with water, the mixture has the character of a fluid. This character slowly changes to a rather jelly-like consistency and finally hardens into the final set stage. It has been proved experimentally and practically that if mixing is continued by hand or with a mechanical mixer to the point where the plaster "draws" or begins to change from a fluid to a creamy plastic mass the compressive strength of the castings made from this mix, will be from $^1/_5$ to $^1/_4$ higher than the compressive strength of those made from a mix which is poured as soon as the plaster and the water are incorporated together. This means that the resistance to wear of the casting made from the first mix will be proportionally greater than that of casting from the second mix. Continuation of the mixing to the creamy state seems to give the effect of homogenizing the plastic mass, of preventing the settling which may be experienced with the plaster in its fluid condition, and thereby preventing uneven strength throughout the set plaster. It also aids in freeing the minute occluded air bubbles or pinholes, which are the final cause of failure of a large number of molds. Experience with powerful mechanical mixers, which whip large bubbles of air into the mix and which give from 10 to 15 times the efficacy of hand mixing, has shown in the ceramic and in several other related industries that the internal structure of a plaster casting may be practically freed from pinholes by following the proper technique in mixing. In hand mixes it is advisable to permit the plaster to soak or blend for several minutes before mixing in order to give the occluded air a chance to free itself from the mass. With a machine mix, the time required for

soaking is only that necessary to permit the plaster to become wetted throughout. Mixers have been devised with such powerful agitation that even this time may be eliminated and the dry plaster added to the water under agitation.

When plasters are "creamed" in this fashion the resultant castings are uniform in strength throughout, they show a uniform rate of absorption over their entire surface due to the uniformity of the gypsum crystals, the strength is higher as described and shown in Fig. 1, and the resistance to wear is the maximum which may be obtained at any given water-to-plaster ratio.

If agitation is continued beyond the point where the creamy characteristic is replaced by the "pull" or stiffening of the mix, the strength of the resulting cast may be detrimentally affected. This stiffening denotes rapid crystal formation and continued agitation is certain to break down these crystals. Maximum strength from a given water-to-plaster ratio is possible only when there is undisturbed crystal formation from a thoroughly blended mix. With extremely violent agitation, the crystals may all be broken down, resulting in a putty-like mass which has barely enough strength to hold itself together after it is dried. This condition or modifications of it, in a greater or less degree, is usually referred to as "working the mix through the set," or "killing the set." In hand-mixing operations at a low water-to-plaster ratio, there is little possibility of over-agitation. The hand cannot apply energy to the mixing rapidly enough to keep the crystals from forming a set mass. A high speed, high-powered mechanical mixer, however, can completely kill the set, particularly of a high water-to-plaster ratio mix. If when the "pull" or stiffening starts, more water is added, and the agitation continued, the set is also "killed." The addition of water to a stiffened mix in an attempt to make it plastic again is known as "retempering." Plaster is always detrimentally affected by this practice and it should never be followed.

C. Volume Changes in Plaster

(1) Expansion During Setting When a calcined gypsum is mixed with water and as the resulting mixture gradually changes from a fluid or plastic into a solid, there are certain volume changes which occur simultaneously with the changes in the state in the mixture. In the preparation of plaster models and plaster molds in the ceramic field, the net result of the volume changes is one of slight expansion. Theoretically, as the calcined gypsum used changes its crystalline structure into gypsum during setting, the volume of the set plaster as calculated from its true specific gravity and formula weight should be less than the sum of the volume of the ingredients from which it is made. The true volume of the gypsum crystals in any casting is most certainly

less than that of the plaster and water mixture. The phenomenon of apparent expansion has never been satisfactorily explained, although careful measurements have been made of it. This apparent expansion is of the magnitude of 0.1 to 0.2% under ordinary conditions in a satisfactory plaster. (See curve, Fig. 2.) Expansion gives the plaster the ability to copy faithfully the fine detail of the model or a molded casting. By its slight but positive action, it permits castings made in a rigid mold, and plaster molds made in a rigid case, to free themselves from the extremely close contact which the fluid plaster assumes, and thus renders easy the removal of plaster castings from plaster or other molds. It is possible by the addition of various materials, chief of which are hydrated lime and borax, to reduce this expansion to an almost negligible amount. Plasters which have been treated in this fashion are unfit for use in casting, since they show a powerful tendency to stick wherever they are poured and render the removal of a casting from a mold extremely difficult. On the other hand, plasters which are not properly made will show excessive expansion rendering control on dimensions of castings difficult.

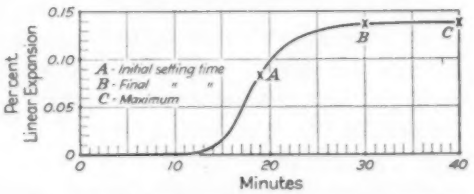

Fig. 2.—Linear expansion curve. Pottery plaster, 70 cc. water per 100 grams. Soak $1^1/_2$ minutes. Mix $1^1/_2$ minutes.

This characteristic expansion during setting requires a special technique in the preparation of plaster molds or plaster cases in which plaster molds are made. The expansion manifests itself in a linear expansion in all directions of approximately the same magnitude. When castings are made in a mold or case in which the expansion is not allowed free travel or movement there are two characteristic occurrences. The casting either expands in the mold in such a way that it binds and the mold must be split to remove it, or the casting, lacking free movement in all directions, will be warped toward the open side of the mold or case by the powerful force of expansion seeking relief toward the single free side. These two characteristics necessitate the preparation of plaster or other molds in such a way and such number of pieces as will give the final casting clearance for free expansion. This is accomplished by the preparation of plaster molds or cases in a number of pieces and in manufacture of large plaster molds similar to those used in terra cotta, the binding together of these molds with spring clips or with fixed bracings which will move in a lateral direction. A necessary adjunct to bracing pieced molds and spring clipping on larger work is the careful application of such surface sealers as shellac, soap, stearin, etc. Treatments of this kind have a two-fold purpose: They seal the plaster case and prevent sticking of the plaster casting in it,

which may be caused by the absorption of the fluid plaster into a porous spot in the case; they also lubricate the face of the case and permit free movement of the casting being made in it.

(2) Contraction During Setting In actual practice, there is sometimes a contraction of the plaster used in castings. A careful study of this has shown that it occurs in the use of a very quick-setting plaster and an abnormally large amount of mixing water, which so disperses the plaster that the resultant casting is weak internally and seems to show a general volume shrinkage. In most cases studied the quick setting has been due to the use of old plaster which has been partly transformed back to gypsum, or has been due to the acceleration of the set caused by large amounts of impurities in the mixing water, by the addition of an excess of accelerating agents or by over-mixing.

(3) Thermal Expansion In addition to these two volume changes which seem to be due to changes in the actual internal structure of the casting, during and after set, gypsum castings also show a very small coefficient of thermal expansion. Exact studies of this characteristic have not been made. They seem to be a function of the apparent density of the casting, which in turn depends upon the amount of mixing water used. A part of the expansion noted during setting may be due to the rise in temperature which always accompanies setting, which is caused by the heat of crystallization or of hydration. This slight thermal expansion is ordinarily of little moment. When molds are dried, however, in a warm drier and then suddenly exposed to low temperature or to drafts of cold air, a surface crazing may develop. This crazing is due to the rapid initial contraction of the surface of the mold which is not followed by corresponding volume changes in the interior of the molds due to the very low thermal conductivity of the casting. The occurrence of this type of crazing due to thermal shock is quite similar to the crazing in glazes on finished pottery, caused by the same type of shock.

(4) General Factors Experimental work on the expansion of plaster during setting has shown that it depends upon several variables which may be introduced in the process of mixing the plaster with water. A study of these variables and their effects shows the following results:

(*a*) Variations in mixing water-to-plaster ratio cause variations in apparent expansion during setting.

As the ratio of water to plaster in mixing is increased the expansion during setting shows a decrease. (See curve, Fig. 3.) As before noted it is possible to use so much water in mixing that a shrinkage or a negative expansion may be experienced. Mixes of this type are difficult to repro-

duce unless complicated by quick set due to the previously mentioned reasons.

(*b*) Variations in fineness seem to produce variations in the expansion, generally speaking, the finer plaster giving the larger expansion at any given water-to-plaster ratio.

(*c*) Variations in setting time seem to cause variations in expansion, the quicker setting plaster showing the greater amount of expansion, as a general rule.

(*d*) Increases in the length of mixing time, which has a secondary effect of accelerating the set, seem to cause an increase in the total expansion.

(*e*) As a matter of experience the expansion of any plaster and water mixture during setting seems to be somewhat a function of the apparent viscosity of the mixture as affected by mixing; in general, the thicker the appearance of the mixture the greater the total expansion.

(*f*) The age of the plaster up to the point of its stabilization as hemihydrate has an effect on the expansion. In general, the fresher the plaster, the greater the magnitude of expansion. This expansion may be controlled by chemical aging in processing.

(*g*) Added substances: lime, borax, etc., have various effects.

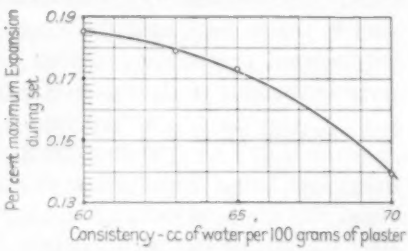

FIG. 3.—Effect of mixing water variation on linear expansion of pottery plaster under uniform mixing conditions and temperatures. Initial temperature, 20°C; soaking time, 1½ minutes; mixing time, 1½ minutes; initial expansion, 11 to 12 minutes; setting time, 17½ to 19½ minutes; maximum expansion, 40 to 41 minutes.

This characteristic of expansion has been studied in the past and studies of the effect of the various manipulations on it are still being continued. These studies to be of value will include all of the variables noted above and they have not as yet been put into proper shape for presentation. Fortunately they are of small magnitude, and this magnitude may be held to a uniform amount by uniformity of manipulation in plaster handling practice. It may be stated that when the water-to-plaster ratio is being controlled, where the mixing time is being held uniform, and where cleanliness in mixing and proper storage of the plaster are maintained, uniform satisfactory results are obtainable and they are being obtained in actual practice.

D. Setting Time of Plaster: Accelerators and Retarders

Plasters, as used in the ceramic and allied industries for general casting purposes, contain no materials for the control of the setting time. In other words, they have the normal setting time of calcined gypsum without the addition of accelerator or retarder. This setting time, when determined under standard conditions, will vary from 25 to 40 minutes for final apparent set to take place; that is, from the time the plaster is mixed with water until the time a casting may be handled without damage.

This time is also subject to variations in handling the plaster, exclusive of the addition of any foreign materials which will retard or accelerate the set. Some of the factors affecting the set of a normal plaster in normal use are as follows:

(1) Contamination When mixing vessels are improperly cleaned and small crystals or scales of set-up plaster get into the mix from the mixing vessels, mixing equipment, or the mixing water, the time of setting of the plaster mix will be accelerated. This acceleration is due to the seeding action of the gypsum crystals which contaminate the mix and which, dispersed in the mix during mixing, may bring the final setting time down to as quick as 7 minutes.

(2) Improper Storage of Plaster When plaster is improperly stored and exposed to a large amount of moisture it will become contaminated with the same kind of crystals met with in using dirty utensils or mixing water. They will act in the same way toward accelerating the set, and when present in large excess will cause weakening of the cast, acting as so much inert filler.

(3) Mixing Time As the time of mixing is increased the setting time is shortened. This is especially true if mechanical mixers are being used. When mixing is continued until set begins to take place, the mass of calcined gypsum and water will harden immediately after the mixing has been stopped.

(4) Temperature Differences The set of a plaster-water mix is the quickest at temperatures between 95 and 105°F. Above and below these temperatures the setting time is somewhat slower. The point of maximum solubility of gypsum in water lies between these temperatures.

While the difference in time of set due to temperature difference is normally small, usually being no more than 2 or 3 minutes, it is enough so that it may cause considerable trouble in a mold room where operating methods have been speeded up and where the set must be exactly uniform.

(5) Contamination in the Mixing Water Water which contains alum, or set plaster, or any one of a large number of electrolytes in solution, may cause quick setting. In contrast to this if the water contains organic materials or some of the organic acids it may cause trouble with slow setting. It has been stated that water which is fit to drink is fit to mix with plaster.

(6) Acceleration and Retardation The fact that a large number of materials have an effect on the set of plaster, retarding or accelerating it as the case may be, demands scrupulous cleanliness in handling plaster mixes if a uniform setting time is to be maintained. As a general rule the addition of foreign substances is unsafe in casting practice or in mold making, because, in addition to

causing variations in the set, they affect the expansion, the internal structure of the cast, the rate of expansion, and the total expansion, and they may have a serious weakening effect on the strength of the set plaster. There are a large number of uses for calcined gypsum, however, in which the set must be changed to fit the needs of the user. In dental practice, for instance, there is a wide range of accelerated plasters starting with a set as quick as 2 minutes and extending to the normal set of the plaster. In the use of plaster for interior decoration and ornaments and for wall plaster, the set of the plaster may be retarded so that it does not harden for 20 or 30 hours or more.

The materials which cause plaster to set in less time than normal are called accelerators; those which extend the time of set longer than normal are called retarders. The setting action of calcined gypsum in water is a physical-chemical reaction, requiring the solution in water of the calcined gypsum and its subsequent precipitation as gypsum crystals, or the transformation of the calcined gypsum to a colloidal gel of hydrated calcium sulphate from which gypsum crystals will grow. It is evident that any condition which affects the rate of solution, the rate of gel formation, or the rate of crystallization, will have an effect on the set. An enormous amount of work has been done in an effort to classify materials according to some logical system as retarders and accelerators, with only a fair degree of success.

It has been found that the mineral acids, hydrochloric acid for instance, will accelerate the setting by increasing the solubility. On the other hand, some of the organic acids such as tartaric or citric acids, and some of the organic salts, like potassium acid tartrate, act as retarders, the effect on the solubility being offset by the probable formation of colloidal intermediate products which retard crystallization. Common salt acts as an accelerator in small quantities, presumably by its effect on the solubility. In large quantities, however, it acts as a retarder, seemingly because its solubility effect has been offset by its powerful action in retarding gel formation. Materials such as powdered gypsum or finely divided, insoluble, crystalline materials act as accelerators by offering centers of crystallization, in some cases without any apparent effect on the rate of solution or solubility of the gypsum. Colloidal materials such as glue, gelatin, and commercial retarder slow down the time of setting by their action as protective colloids in retarding crystallization.

The safest accelerators and those in most common use are made up of finely powdered gypsum crystals or are electrolytes such as potassium sulphate, which seem to enter into combination with the set gypsum and do not subsequently effloresce. The most common retarder in general use is a product known as commercial retarder, which is manufactured

from hair and horny organic material by hydrolysis and subsequent extension on a colloidal medium like lime or clay.

Except where it is absolutely necessary the use of retarders and accelerators is not recommended in ceramic practice or in general casting practice because of the difficulty of getting a uniform dispersion of the accelerating or retarding medium in the mixture. This unevenness of dispersion may lead to hard spots, uneven wear, and uneven expansion of the plaster during setting. Where necessity demands the use of these materials away from the point of manufacture the best practice is to dissolve them in water if they are water soluble, or to suspend the finely ground material in the water used for mixing.

E. Temperature Changes During Setting

The chemical reaction, which takes place when the hemihydrate form of calcium sulphate combines with water to form the dihydrate or set-up plaster, is an exothermic one, that is, it gives off heat. In small casts with considerable surface exposed to the circulation of cool air, this temperature rise is not very noticeable. But in large casts or casts closely confined in a mold the net change in temperature may be 30°F or more. A typical time-temperature curve is shown in Fig. 4.

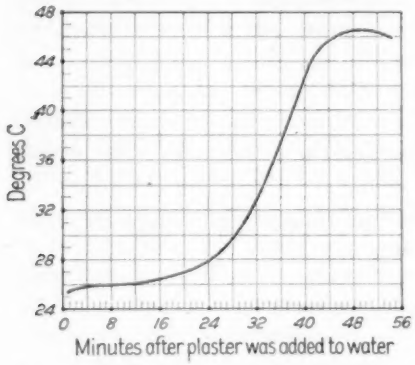

FIG. 4.—Time-temperature curve for pottery plaster. Seventy cc. of water per 100 grams plaster.

In the ceramic industry the temperature rise is usually not important, but in art casting work, where glue or gelatin molds are used, it is of great importance. The temperature rise, unless carefully controlled, may result in melting or "burning" the mold. For this purpose a plaster is needed which quickly develops strength after setting, but which heats up slowly. The casting must develop strength quickly enough so that it may be removed from the mold before the heat becomes excessive.

Casting shops which use gelatin molds commonly keep ice in their mixing water during hot weather to keep down the maximum temperature developed during the hydration process.

F. Drying of Plaster Molds

As has been pointed out, a plaster mold or other plaster casting after it has set, contains part of the original water, used in mixing the calcined

gypsum, as free water. To develop the maximum absorbent power of the mold this free water must be removed. When any set plaster is permitted to remain undried, it slowly becomes softer and loses strength. The causes of this loss of strength are not well known, but there seems to be some change in the internal crystalline structure of the set plaster. This weakening is called "sweating" or "rotting." Similarly if plaster molds are used for the purpose of shaping clay and are permitted to lay wet over a period of time they gradually lose strength due to this "sweating." This gradual loss of strength is accompanied by more rapid wear of the surface of the mold and consequently shorter mold life than would normally be expected. This condition calls for some positive means of drying out the molds regularly, and it has become common practice to allow a certain period in every 24 hours for the molds to be dried out. The rate of apparent weakening of a plaster mold by "sweating" is roughly proportional to the apparent density of the mold, which in turn is a function of the water used in mixing the plaster. That is, a mold mixed with a large amount of water or made from a thin mix of plaster will appear to weaken due to "sweating" more quickly than a mold made from a heavy mix or one using a minimum amount of water. This apparent more rapid softening of the lighter mold seems to be due to the fact that the mold has not the original strength, and therefore slight weakening is much more easily noticed.

In order to prevent this weakening, as well as to keep the molds in the proper state of porosity, artificial drying is commonly resorted to. In the best practice there is used a mangle or drier in which the temperature and the humidity of the air is under control. This calls for recording thermometers as a check on maximum temperature, control of the humidity of the air, and also calls for proper circulation of air to prevent local overheating and consequent destruction of the plaster mold due to this local overheating. This overheating, called "burning" softens the mold faces by a recalcination of the set mold back to calcined gypsum. It is evidenced by the chalky condition of the back or on the exterior of the mold, sometimes accompanied by hair-line cracking. When this hair-line cracking or softening occurs the life of the mold is seriously reduced, in some cases the mold being unfit for use after it has been exposed to abnormally high temperature.

Because of the urge of lower production costs during the past five or ten years, mangle and drier temperatures have been increased and the speed of travel of molds and ware have been increased proportionally, in the effort to get a greater number of turns of ware from each mold out of a day's run. In a number of cases the increased yield of the equipment has more than offset the shorter mold life caused by these higher temperatures used. In other cases, the speed has been obtained, but the

shortening of the mold life has been laid to defective plaster rather than to the changed conditions.

It has been determined experimentally and practically that as long as there is free water in a mold it will withstand temperatures up to the boiling point of water (212°F). As soon as the free water is removed, the edges and the parts of the mold exposed to this high temperature begin to recalcine. Various investigators have placed maximum drying temperatures at from 120 to 150°F. Experience has shown that temperatures above 150°F maintained for several days on a dry mold are enough to cause surface failure. For this reason thermometric control and maximum operating temperatures of 150°F are advisable when the length of time in the drier may be excessive. This slow recalcination of molds described is purely a time-temperature reaction. The rate of transition from one stage to the other below this temperature, however, is so slow that under normal conditions of operation it is never met with, except at extremely low relative humidities and exposure over long periods of time.

The condition of surface crazing of plaster molds has been described in the section under Expansion. As pointed out there, it is due to thermal shock caused by bringing dry hot molds into contact with cold air, the resultant thermal contraction on the surface in some cases being enough to crack the surface of the mold. This condition appears to occur only when the molds are dry so that all free water has been removed from them. Generally speaking the denser or stronger the mold, the more liable it is to surface crazing due to thermal shock.

G. Surface Hardness of Molds

The surfaces of plaster molds may be hardened experimentally by the use of dextrin, gum arabic, and various other colloidal substances. In practice, however, treatment of this kind reduces the rate of absorption on dry molds, and is valueless when damp, since then the hardened gum has a tendency to soften. Treatment of the plaster surfaces, whose function is that of absorbent, with any material which will harden them, will tend to seal the absorbent surface and thus render the mold less fit for its purpose.

Various methods have been devised to determine the surface hardness of a plaster mold, in an effort to get an index of the wearing qualities of the mold. One of these methods uses a modification of the Brinell hardness tester for steel, that is, a ball pointed, weighted instrument pressed on a plane surface of plaster. The diameter of indentation into the plaster made by this spherical point under a constant pressure has been used as an index of the surface hardness. All methods are open to the objection that plaster molds which contain water are weaker than the dry molds, and that they grow still weaker on the surface either by "sweating" or

by calcination when used. This means that any surface hardness testing would only be an index of the hardness of the mold under the condition of the test.

The compressive strength, the tensile strength, and the production of a mixture of plaster and water which is of uniform texture throughout seem to be the deciding factors in the mold life. The strength factors are decided by the uniformity of the mix and the amount of plaster in a unit volume. Since the strength increases in proportion to increases in weight, that is, to decreases in the mixing water used, it is evident that there will be more plaster on a given area to withstand abrasion and solution in a dense mix than in a light mix, and there will be consequently slower wear in the dense mix. It is for this reason that emphasis is placed on the plaster-to-water ratio and the carefulness of mixing.

The best mold that it is possible to produce will, of course, gradually wear out. Abrasion from the clay mix will in time wear down the surface to such an extent that the additional material required in a piece of ware more than offsets the cost of a new mold. Because of the cost of the additional clay mix required, which also affects the final weight of the ware, some ceramic plants have concluded that it is cheaper in the long run not to use molds up to the point of being completely worn out but arbitrarily to discard them after they have yielded a certain definite number of turns. This point is determined by balancing the cost of a new mold against the cost of the additional clay mix in the old mold.

H. Effect of Electrolytes Used in Casting Processes on Mold Life

The common electrolytes used as deflocculents for clay slips have been sodium carbonate or sodium silicate. Both of these materials react chemically with calcium sulphate forming sodium sulphate and the corresponding carbonates or silicates of calcium. The sodium sulphate is highly soluble in water and is carried through the mold to be deposited on or in the mold surface at the point of evaporation of the water during drying. Under cool conditions of relatively high humidity it is deposited as long feathery needle crystals of Glaubers' salt (sodium sulphate with 10 molecules of water of crystallization). Under the usual forced drying conditions with air at relatively low humidity, sodium sulphate is brought to the surface or in the surface as crusts which cause surface pitting and wear. It is for this reason that evaporation from the active absorbent faces of a mold should be reduced to the minimum in all molds used for slip castings.

The insoluble calcium carbonate and calcium silicate formed at the same time gradually deposit on the active face of the plaster mold. The deposition continues until at times the entire face of the mold has been transformed from plaster into these constituents. Where plaster is used for this type of casting the surface deposition of calcium carbonate and

silicate is the usual cause for mold failure. Sometimes it is possible by scraping to remove the surface deposits and in this way expose fresh plaster surfaces for absorption. At other times crusts of these calcium salts will flake off and cause surface pitting in the mold, sometimes sticking in the body of the ware and causing a flaw.

Recently the use of organic deflocculating agents has been started in a few plants. These materials serve the same purpose as the alkalis, and they do not have the harmful effect on the plaster mold characteristic of the alkalis. Wherever high alkali content of slip clay is now being used, with the consequent short mold life, investigation of these organic deflocculents will undoubtedly be rewarded by methods which will give increased mold life and better surface character of the finished ware.

I. Diagnosis and Correction of Common Troubles with Plaster Molds

The foregoing discussion of some of the characteristics of plaster and plaster molds leads us naturally to a study of the common troubles met with in the use of plaster, and methods for their prevention or control. Chief among these are the following:

(1) **Pinholes** Plaster, being an extremely fine powder, normally carries air around the surface of each particle. In addition, it is evident that the water removed from the gypsum particles in calcination has been displaced by air; when this finely-powdered plaster is added to excesses of water, the air around each particle, as well as the air within the particle will have a tendency to flow together into small bubbles of visible dimension in the mix. These bubbles, if they are not removed during the blending or the mixing process, remain more or less uniformly distributed throughout the mass of the mold. When the mold is put into use, especially in pressware and terra cotta, or whenever abrasion or solution in water tends to remove the face, more and more of the small visible bubbles of the order of $^1/_{64}$ to $^1/_{32}$ inch diameter will show up. As they become prominent, they gradually render the ware, being shaped in the mold, rough in surface appearance. This roughness is caused by the imprinting of the pinholes on the body of the clay. When they become numerous enough, the mold must be discarded as worn out.

In those potteries where hand mixing is practised, the custom of blending for from 2 to 5 minutes before mixing is commenced, permits the pinholes to coalesce into bubbles of air large enough to be freed when the mix is later agitated. If the plaster is sifted into water and mixing begun immediately the mass becomes plastic and offers resistance to the coalescence of the air bubbles, so that further mixing only tends to give them even distribution. After the blending has been performed, mixing by hand over a period of from two to four or five minutes is necessary, and if the bubbles come to the top of the plaster as scum, they must be re-

moved by skimming, otherwise they will be poured into the mold and give bubbles on the face. In making hand mixes, extreme care is required both in blending or soaking and in mixing in order to obtain the maximum freedom from pinholes.

In machine mixing it is necessary that the plaster be wetted thoroughly, and the blending stage is not so important. This is for the reason that practically all machine mixers whip large bubbles of air into the plaster mix, and these serve to dredge the pinholes out of the mix in a manner similar to the clearing of a molten glass batch by the decomposition of part of the batch into gases which form large bubbles.

Machine mixing is being so carefully performed in some plants at the present time that pinholing in the mold body is a rare occurrence. By eliminating this condition the loss of molds due to pinholing is cut down to a minimum and the limiting life of the mold is the loss of the detail by abrasion of the clay.

Some plasters show more tendency to occlude air than others. For this reason a good ceramic plaster should be made with such careful attention to particle size that this tendency is kept to the minimum consistent with uniform texture and high strength.

(2) Hard Spots on Mold Surfaces Hard spots on mold surfaces may show up either as high places which do not wear down as rapidly as the rest of the mold, or as spots of slower rate of absorption than the rest of the mold which may at times cause sticking of the clay to the mold with a consequent defective surface on the ware.

Chief among the causes of hard spots in a mold is an uneven mix, that is, a mix in which the plaster and the water have not been evenly incorporated, resulting in some sections where the set-up plaster has been mixed using less water than others. The places where less water is used will be hard and will not wear down as rapidly as the rest of the mold. At other times, hard spots may be due to pieces of set plaster scale from the mixing vessel falling into the case and being incorporated into the face of the mold when it is cast. The remedy for these conditions is proper attention to mixing and to cleanliness.

Another condition which causes hard spots on the face of the mold, particularly in terra cotta practice, results from the character of the set plaster mold. Set plaster is soluble in water to a slight degree, the solubility varying from one part to 400 parts of water to one part to 500 parts of water. This solubility is such that if the mold is dried from the face or absorbent side, the water coming out from this side will deposit in the surface of the mold the gypsum which it carries in solution. As evaporation from any surface under normal conditions is not uniform throughout, the points of greatest evaporation will become harder and

denser due to this deposition of gypsum, and may finally become so dense that the rate of absorption becomes negligible. The remedy when this occurs lies in scraping the hard spots, and wherever possible in forcing all evaporation to take place away from the active face of the mold.

Various substances such as oil, shellac, or other water-repellent materials may act to give the effect of hard spots by reducing the rate of absorption, if they happen to be splashed on the face of the mold. Soap has a similar action, since it reacts with the plaster face of the mold to form a hard soap which repels water. As a result of this water repellence the clay shape being made in the mold may not be properly dewatered at these points and defective ware may result. When plaster molds are cast in plaster cases, the water-repellent action of soap is used to prevent sticking of the plaster casting by absorption and consequent crystallization of the mold to the case. The absorptive action of plaster on clay is just the opposite, that is, as the plaster draws the water from clay, the clay pulls away from the plaster. If the absorption does not take place the clay remains in intimate contact with the plaster and cannot be successfully removed.

(3) Cracking of Molds As outlined in the section covering Expansion and the section on Drying, there are several types of mold cracking, exclusive of the failure due to mechanical shock. These are:

(*a*) Surface crazing due to thermal shock by exposing hot molds to cold drafts of air. This type of crazing is accompanied by no noticeable softening of the plaster surface.

(*b*) Surface crazing or cracking due to recalcination caused by drying at excessively high temperatures. This type of surface cracking is usually accompanied by a very noticeable softening or tendency to become chalky. It may sometimes occur on the same molds which show crazing due to thermal shock, because of the high temperatures reached during recalcination.

(*c*) Where iron or other metal which will corrode and expand is present as reënforcement in the mold, the mold life may be shortened by the expansive action of the products of corrosion. This condition takes months to occur and usually does not show up since the molds wear out from use. Where molds with metallic reënforcement are used the corrosion due to the action of water on the metal may be retarded by using oiled or painted metal or wooden reënforcement, although this latter does not give the same reënforcing value as metallic members. Molds which are reënforced with metal stripping which may corrode should be kept in a dry place as the metal will not rust in the absence of water.

There is another type of cracking which is rarely met with, caused by the differential expansion resulting from the pouring of a thick mix of plaster on a thin mix which has not been properly roughened and has gone into its initial set. When this type of expansion occurs, it occurs during

or immediately after the set of the plaster and may be recognized at once. It has only been observed in large molds where heavy metallic reinforcing was used.

(4) Quick-Set Troubles Quick-setting troubles may develop due to contamination of the plaster with set plaster from the mixing vessel or from the water supply, from the presence of partially set plaster in the plaster bags, caused by long aging in a damp atmosphere, or by exposure to water, or they may at times be due to the presence of excesses of soda or alum in the water from water treatment processes.

A most common cause of quick setting is the continuation of the blending time for such a period that during the mixing of the plaster and water they are mixed into the initial setting of the plaster. When this occurs, the gypsum at first formed in the initial set is dispersed throughout the plaster mix and thus rapidly accelerates the final set.

Another cause of minor variations in setting is the use of water of varying temperatures. The use of warm water is usually accompanied by quickened set, the amount of the acceleration being determined not only by the temperature of the water, but by the amount of mixing performed. Variations in temperature may cause variations in set of from 5 to 10 minutes, depending on the amount of mixing.

(5) Slow-Set Troubles Where the use of warm water has been customary, a change to cold water will evidence itself in a slight retarding of the set. If, at the same time, the amount of mixing has been reduced and the mixing water and all the vessels are in a clean condition the setting time obtained practically may be slowed down by as much as 5 minutes over the normal time.

Very rarely slow setting conditions develop from contamination in the mixing water. Substances like sugar, borax, powdered glue, and tartaric or other organic acids may cause this difficulty. Tannic acid, for example, is a powerful retarder in amounts as low as 0.1 of 1%. These substances are very rarely encountered in a plaster shop.

(6) Soft Molds The causes for soft molds as originally made or for the later softening of normally hard molds may be summarized as follows:

(*a*) Too much water used in mixing resulting in lowered strength.

(*b*) Improper attention to drying resulting in the softening of the molds due to their lying wet over a period of time with resultant "sweat-out" or "rot-out."

(*c*) Too high drying temperature resulting in recalcination of the surface of the mold. This condition can be recognized if the interior of the mold is hard and the surface only is powdery, which is the customary appearance of a recalcined mold, the interior of the mold not being affected by the heat.

(*d*) When plaster in storage absorbs water out of the air and becomes quick set, it is quite frequently necessary to use excesses of water in mixing, particularly after the plaster begins to get lumpy in storage.

(*e*) Sometimes efflorescent crystals of sodium sulphate form in, as well as on the surface of the mold. When this occurs the surface of the mold disintegrates by an action quite similar to the action of frost. This is a rare condition when uniform regular drying methods are followed out.

(7) Efflorescence As described before, the visible efflorescence on molds is usually sodium sulphate. Any water-soluble material in the clay, however, which does not react with the gypsum of the mold and which is crystalline in nature may show up as surface efflorescence. Magnesium sulphate is typical. As described in the section on Hard Spots, the deposition of gypsum carried in solution seems to take place in the body of the mold when it is dried, and does not come out as a powdery efflorescence. Gypsum plasters for all purposes are selected as to source in order to be free from efflorescent impurity. It may therefore be stated positively that any efflorescence which appears on a plaster mold has been formed in the mold or has been added to the mixture at some time during its manufacture or use in the pottery.

(8) Expansion Difficulties The thermal expansion of a plaster mold and the slight expansion and contraction noted when the mold is wetted and dried, are usually of such magnitude that they may be neglected. The expansion during set, dependent on the thickness of the mix, may cause serious difficulties if not properly provided for, as described in the section under Volume Changes. When a mold of any length greater than 3 feet is cast against a rough surface, the ends of the molds should be so clamped that the expansion which occurs will either have free clearance or will be taken up in a slight deformation over the entire face of the mold.

The best assurance against warping or swelling troubles due to this characteristic expansion, lies in maintaining a constant plaster-to-water ratio and a constant mixing time. This is particularly true if more than one mix is being poured into a case. Where this occurs the heavier mix will take the greater expansion and may put a negative warp into the resultant mold or casting if it is not properly braced, whereas if the same proportions are used for each mix the tendency to warp will not be so great.

Differential expansion or warping may occur in the casting of large monolithic slabs which contain metal reënforcing, unless this reënforcing is placed midway between the opposite faces of the slab. When too close to one face, expansion of the metal, caused by the temperature rise in the plaster during setting, is counteracted by unequal thicknesses of plaster, and warping occurs toward the weaker side.

(9) Summary Study of the characteristics mentioned and of the typical complaints experienced lead us to the following summary of the proper method of handling plaster:

(*a*) Storage of plaster, until it is used, in a dry protected place, free from air current. The stock should be properly rotated so that all old material is used before a new shipment is started.

(*b*) Careful control of water-to-plaster ratio gives control of the strength, of the expansion, of the total volume of set plaster obtained, and therefore the yield per ton of plaster. It enables close control of the total absorption of the mold, giving uniform surface when the mold is put into use.

(*c*) Proper attention to mixing will develop the maximum strength that is in the plaster and thus give the longest life at any given water-to-plaster ratio. It will reduce to a minimum the tendency to occlude air, thus giving the maximum amount of ware from the mold with a minimum of surface defects due to pinholing of the mold caused by the occluded air. It will prevent unevenness in absorption and in hardness throughout the mold which might lead to defective ware when the mold is put into use.

(*d*) Cleanliness and controlled mixing time, preferably using a mechanical mixer, will maintain a uniform set and prevent hard spots due to contamination.

(*e*) Proper attention to drying of the plaster molds, preferably using recording thermometer control in the drying rooms and mechanical forced circulation of air, will prevent recalcination of the mold with consequent softening and surface cracking. Proper attention to drying will also eliminate the danger of softening of molds due to "sweating" when they are allowed to remain wet.

(*f*) The use of organic deflocculating agents in place of alkalis will give longer wear from molds used in slip castings since they do not have the capacity to react destructively with the molds.

A discussion of the methods of testing and of analysis which are used in controlling the physical character of pottery plaster and other calcined gypsums will follow. The aim of this discussion is to give a better understanding of the general characteristics of gypsum castings, whether as models, molds, or as absorbent bats, in the ceramic or related industries.

VI. Tests and Test Methods

A. Physical Tests

(1) Setting Time As pointed out previously, the practical value of calcined gypsum lies in the fact that when mixed with water, the resultant plastic mixture changes to a hard substance, composed of a mass of gypsum crystals, and the hardening, or "setting," is controllable as to the time interval which elapses between the mixing of the plaster and water and the final hardening. There are various physical phenomena attendant on the setting. (1) The fluid or plastic mixture

retains its plasticity for a time; (2) it gradually stiffens, and (3) finally becomes hard. (4) Careful measurements show that during the stiffening period there is a positive expansion when no admixtures with the plaster are made excepting water. As the hardening progresses, (5) the reaction of solution and crystallization may be followed by the temperature rise of the mixture.

The determination of the setting time, and its uniform control, calls for a rather exact method of time measurement. Several methods have been devised. The standard method recognized by the A.S.T.M. is the use of the Vicat apparatus, which consists of a weighted needle, dropped from a fixed height into a measured depth of the mix being tested. Results obtained by this method, although they can be duplicated, do not practically define the complete setting of plaster. Methods have been devised whereby the point of maximum temperature rise from the time of initial mixing can be measured. Under uniform mixing conditions, this point also may be duplicated. It is closer to the point of final setting than that obtained with the Vicat needle. A third method in common use is the Gilmore needle, the time of set being called when the needle makes a uniform penetration into the plaster mass or patty. This method has the advantage that the time measured corresponds quite closely to the practical time in which a casting may be handled after the plaster has been poured. It measures neither the final set as determined by temperature rise measurement, nor a uniform stage in the gel formation which will support a needle of fixed weight, but corresponds closely to the time interval in which a casting must remain in a mold before it may be handled. This test by the Gilmore needle follows approximately the time in which a small patty of plaster will expand sufficiently to free itself from a smooth glass plate. It also corresponds approximately to the hardness at which the crystalline character of the set plaster can be determined by pressure with the finger or the finger nail. These two latter methods are in common use by men who handle plaster practically.

(2) Consistency Consistency, or normal consistency, as we refer to it, is the number of cubic centimeters of water which must be mixed with 100 grams of plaster to give a wet mix which will have just sufficient fluidity to flow from the mixing vessel without the aid of a spatula. In order to arrive at concordant results, it is necessary that this test be performed in a uniform manner. It is customary to hold this consistency figure uniform on each type of plaster. Since a large percentage of plaster is still mixed by hand, and the resulting castings made from it depend for their strength on the amount of mixing water used, the maintenance of a uniform water-carrying capacity is essential to the production of uniform plaster castings.

Various methods of measuring consistency by measuring the slump of a

plaster and water mixture have been devised. These methods, typical of which is the Southard viscosimeter, which is specified by the A.S.T.M., give consistent results. There are also the Hammond and the Rhodes machines employing this principle. A modification of the Vicat needle, in which the needle is replaced by a plunger, is also used. They are rather cumbersome to use, however, and are seldom used except to check the results of the simpler determination, which follows.

(3) Determination of Consistency and Time of Set A 50-gram sample is used in making this test. Since the consistency is expressed in cubic centimeters of water per100 grams of plaster, the water measurement for 50 grams of plaster is multiplied by two in order to get the consistency.

About 85% of the estimated amount of water is placed in a small casserole or round bottomed glass beaker. The first estimate of water needed is made roughly by adding water to a 50-gram sample until it comes to fluidity and can be poured. The 50-gram sample of plaster is sifted, *not dumped*, into the water and allowed to soak for one minute. Sufficient additional water is then slowly added until the plaster is wetted and just covered. The mix is agitated moderately, not whipped, with a small spatula for fifteen seconds and then poured from a height of three to four inches on a thin smooth glass plate. If mixed at normal consistency the mass on the plate will spread out into a circular patty about $^5/_{16}$ to $^3/_8$ inch thick and $3^1/_2$ inches in diameter. A second test is then made, using the amount of water determined in the first test as the starting amount, sifting the plaster in, and mixing as described. If the patty formed is the same as the first in fluidity and spread, the test is complete and no further work is necessary. If the mass is too fluid and pours out too readily, forming a larger pat, further tests must be made, reducing the water slightly each time until the correct size of patty is obtained. The time of set is pronounced at the time when the patty will support the large size (1 lb.) Gilmore needle with no difference in the depth of indentation on successive trials made at one-minute intervals. The time of set is measured from the time the plaster is added to the water. The indentation method of using the Gilmore needle is preferred, since some plasters may be of such high normal consistency that even when set they will not support the needle without indentation.

(4) Fineness The fineness of plasters is ordinarily determined by screen testing. Sieves in common use are the 40-mesh, 100-mesh, 200-mesh, and 325-mesh. The mixing character, the working quality, the texture of the finished cast, and to some extent the strength of the set casting are dependent on the fineness of grinding. In addition to the screen testing, comparative determinations as to the amount of ultra fines or "flour," finer than the finest mesh testing screen, are made

by the use of various wet and dry bulk tests. In pottery plaster and other plasters where smoothness of texture and freedom from pinholes are required, a comparison for pinholes is made against a standard sample using a section of the set plaster being examined for comparison against a section of standard.

The screen test is conducted by accurately weighing out one or more samples, usually 50 grams each, representative of the shipment. These are placed in the desired testing sieves and shaken either on the Ro-Tap, Sturtevant, or other vibratory machines, or by hand, until not more than 0.5% will sift through the screen in one minute of hand screening. Too severe or too lengthy screening results in wearing the particles down to such size that they pass through the meshes of the screen. This wear is due to the natural softness of the calcined gypsum particles. The results obtained by weighing the residue and deducting from the original weight are expressed in terms of percentage passing through the individual testing sieves.

As described, the testing methods on gypsum for flour content have been empirical in that bulk tests and texture comparisons against standards have been necessary as a measure of the correct amount of this flour. Wash tests with water are of very little value since the plaster goes into solution; wash tests with other materials in which plaster is insoluble have never come into favor. It is probable that air-separation methods, which have in recent years been carefully studied, will be applied to plaster if their value can be proved.

(5) Compressive and Tensile Strength Determination In making determinations of compressive and tensile strength, the methods outlined by the A.S.T.M. are used. The plaster is mixed to normal consistency with water and 2- by 4-inch cylinders are cast for compressive strength determinations. Standard briquets exactly one inch in cross-section are cast for the tensile strength determination. The tests are performed on the specimens only after they have been dried to constant weight. Strength determinations made on plaster specimens carrying a small percentage of free water show very little more strength than the original wet casting. This wet strength is generally from $^1/_3$ to $^1/_2$ the ultimate dry compressive or tensile strength.

(6) Color Control When color control of a plaster, such as pottery plaster, is required, it is customary generally to make a dry color comparison. The sample to be tested for color is taken from the center of the container so as to be free from surface contamination. It is thoroughly mixed in a clean container. Then, about 5 grams of sample are placed on a clean colorless glass plate in indirect light, preferably reflected northern light, or from an artificial day-light lamp. An equal amount of the standard sample is placed next to the sample being tested

and both are then flattened together with a clear glass plate on top. Any difference in color is readily noticed by a definite junction line.

When wet color comparison is desired, the sample being examined and the standard are mixed to normal consistency and poured side by side on a colorless glass plate and allowed to set. The bottoms of the set patties, which have crystallized together in the set, are then examined for the line of juncture.

B. Chemical Tests

Chemical analyses on calcined gypsum are always made following the method outlined by the A.S.T.M. when complete analyses are desired. Control analyses on the plasters from any given locality are made by analyzing only for the gypsum content and the insoluble content. The residual impurities in calcined gypsum from any given location remain approximately uniform in chemical constitution.

Analyses of calcined gypsum, while seemingly simple, must be performed with extreme care as to the mechanical treatment, the temperatures, and the exposure to the atmosphere. Calcined gypsum, as freshly made and properly stored, consists of the hemihydrate with, at times, small percentages of natural anhydrite, or of the second settle anhydrite, the so-called "soluble" anhydrite. As these products age, the natural anhydrite content remains unchanged, the soluble anhydrite hydrates to the hemihydrate, and the hemihydrate moisture content increases above the theoretical by the apparent adsorption of water without a simultaneous visible crystallization to gypsum. As long as aging has not progressed to the formation of gypsum in the dry plaster, the time of set of the plaster is not affected. As aging continues beyond this point, however, some of the adsorbed moisture gradually causes crystallization of gypsum in the dry plaster, this crystallization at times causing lumps of plaster loosely bound with gypsum to form in the containers. Any given sample of plaster may contain all four of these various forms. Moisture determinations made on the dry plaster, moisture determinations made on the dry set-up plaster, and microscopic examination both of the dry plaster and of the set-up product must be made. Methods of analysis have been outlined which depend purely on the microscopic appearance of the plaster. Another method has taken for its basis the hydration and dehydration of the plaster with sulphuric acid of various concentrations as a control on the vapor pressure. The skill required in making a fairly accurate analysis of a calcined gypsum sample, and the experience required, is on a par with the skill required in modeling and molding plaster in the ceramic industry.

In recent years the use of containers which are practically impervious to the action of the atmosphere under ordinary storage conditions has done much to stabilize plaster in all of its various uses.

C. Conclusion

An attempt has been made to outline the most important characteristics of gypsum and the products made from it. The discussion of the chemical and physical properties and of some of the tests applied to calcined gypsum may be used for reference. The troubles encountered in the use of plaster in the ceramic industry have been enumerated, completely, insofar as our experience with them has gone. The causes, and the methods of correction based on the physical properties of the products, have been given. The service obtained from plaster castings will depend primarily on their being made and handled as has been outlined. The facts given have been assembled in the hope that they will produce a better understanding of the material, with a resultant economy in its use and in the manufacture of the various ceramic products in which it serves as a tool.

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CONSTRUCTION OF WATER-TIGHT BRICK MASONRY[1]

By F. O. Anderegg[2]

ABSTRACT

About 300 panels have been erected to determine the effect of some of the various factors of different brick, mortars, workmanship, and design in causing leaky brick walls. The brick varied in absorption from 0.6 to over 12% of their weight when placed flat side down in 1/8 inch water for ten minutes. The mortars included both lean and the richest mixes of lime and Portland cement in varying proportions and of a large number of masonry cements. Most of the panels one brick in thickness leaked in half an hour on being sprayed with a hose. A very few mortars were found that were quite tight. Those panels with an air space between the front and the backing allowed no water to pass clear through the wall. Many panels have been broken in flexure with very interesting and important results. Other panels have been built to test out interior ventilation of walls, and many other points have been studied.

Introduction

One of the most important problems facing the building industry of today is probably that of leaking brick walls. The recent expenditure of over one hundred thousand dollars in trying to make a single building in New York City tight against rain gives some indication of the seriousness of the situation. A brick wall is made up, according to different specifications, of a large number of small units laid up one by one and by hand, in a mortar which may vary widely in composition. The brick manufacturer, the producers of cement and lime, the building supply dealer, the architect, the contractor, the mason, and last, but not least, the owner should all be concerned in the results. Probably the most important member of this team is the brick mason, for upon his workmanship, more than upon any other single factor, rests the responsibility for the integrity of the wall. It is his to make or to mar, and everything should be done by other members of the team to make conditions conducive, as nearly as possible, to the securing of 100% workmanship.

An investigation has been undertaken by the Eastern Face Brick Manufacturers' Association in coöperation with the Portland Cement Industrial Fellowship of Mellon Institute, to determine the causes of, cures for, and prevention of leaky brick walls, and this paper is in the nature of a progress report. A complete study of all the possible combinations of the variable factors that enter into a brick wall would require the performance of hundreds of thousands of experiments, and therefore is obviously impracticable. By careful study of the problems, however, and by selecting conditions representative of the probable range of prac-

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Masonry Meeting).

[2] Senior Industrial Fellow, Atlas Portland Cement Company's Industrial Fellowship, Mellon Institute of Industrial Research, Pittsburgh, Pa.

tical application, it was hoped to get the answers in as convincing a manner as possible, but without so exhaustive an effort. This has been attempted; but it is appreciated that many conditions are bound to arise in so complicated a system which are hard to foresee without a very wide practical experience.

A preliminary analysis of the practical methods, which have been more or less consciously used to try to get brick walls tight, has indicated five different methods of handling the problem:

(1) An absolutely impervious face. The difficulty is to secure 100% workmanship; if moisture gets into the wall in some way, as from a leaky gutter, it is apt to freeze and burst the wall, owing to lack of "breathing" or opportunity for evaporation.

(2) A wall built like a sponge, of sufficient capacity to hold back the heaviest rain. Later the moisture would evaporate from the surface. The objection is that capillary forces are likely to draw the water on through into the interior.

(3) A dam on the back of the wall, composed of mastic or emulsion of asphalt. The position of the asphalt is wrong mechanically, having to resist pressure from within the wall, and any little pinhole will allow evaporation, followed by efflorescent disintegration. Panels have been erected to test the efficacy of such treatment under severe conditions.

(4) A wall designed with an air space. To be effective, the air space should be sufficiently open so that moisture would run down and out through suitable weep holes which should be provided. It seems probable that a vent at the top is desirable (it usually is present by accident). An impervious sheet of asphalted fabric or metal must be placed at intervals, usually at the spandrel beam, to divert the moisture from the interior. An objection is increased infiltration of air, but the weep and vent holes should not be very large or too frequent. A hard plaster inside, moreover, would reduce infiltration to a small value.

(5) A wall built so carelessly as to be full of holes, so that, although the water may get in easily enough, it will run down and out with equal readiness. It is suspected that this is the reason why many cheap houses where the brick work has been "skinned" have been free from leaking walls.

In other words, to get a tight wall either the very best or very poor workmanship may be the answer. But water is undesirable in a wall. While the damage done by a little water is imperceptible, yet a "continual dropping will wear away granite." The winter rain water throughout the north central and northeastern parts of the country contains appreciable quantities of sulphuric acid; this is true in the country as well as around the cities.[3] The result may be observed in many of our older buildings. Water, therefore, should be kept out of the wall just as completely as is practicable.

Hence Method 1 seems to have certain advantages, and perhaps when

[3] Anderegg, Peffer, Judy, and Huber. Purdue Univ., Eng. Expt. Sta., *Bull.*, No. 33, p. 27 (1928).

combined with Methods 3 and 4, by the use of suitable building units and of proper design, the solution of the leaking of brick walls may be secured in an economical manner.

Experimental

More than 300 panels, shown in Fig. 1, have been erected to shed light on what effect the various factors (involving brick, mortar, workmanship, and design) have in causing leaky brick walls.

The Brick The brick were selected to cover a range from low to high total and initial rate of absorption. Some of their properties are listed in Table I. The 10- and 30-minute absorptions were obtained by placing the air-dry brick flat side down in $^1/_8$-inch of water, after which they were completely immersed for 24 hours. The modulus of rupture was obtained with the brick flat and the compressive strengths were secured with the resulting brick bats. Brick G was a special brick of double width with large openings in the middle.

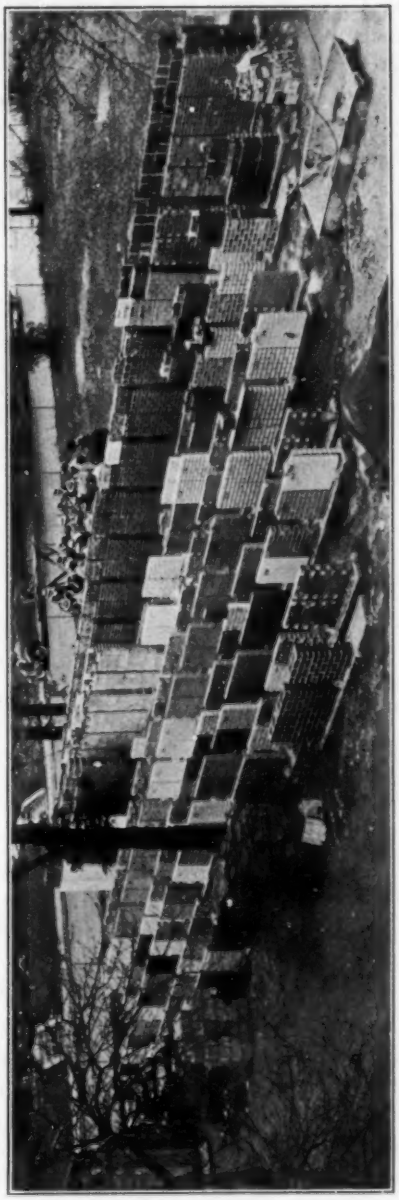

FIG. 1.—Display of experimental brick panels being studied by members of the Eastern Face Brick Manufacturers' Association.

The results given are the averages of from 4 to 8 tests. Naturally, more or less variation occurred; thus the ten-minute absorptions of a very hard-fired sample of Brick B were found to be 1.0, 1.7, and 2.8%, and those of a very soft-fired B were 7.6, 7.6, and 7.6.

Bricks C, D, E, and F were sufficiently impervious that, when built into panels with a tight mortar and with proper workmanship, the whole panel would prevent the passage of water during half an hour of spraying from a hose, or when impounded at a depth of a few inches. All panels built of red brick, A and B, whether laid in water-tight mortar or not, allowed water to pass through in half an hour of spraying.

On the other hand, the "rate of breathing" or the rate at which evaporation takes place from the surface would be low for the brick which held

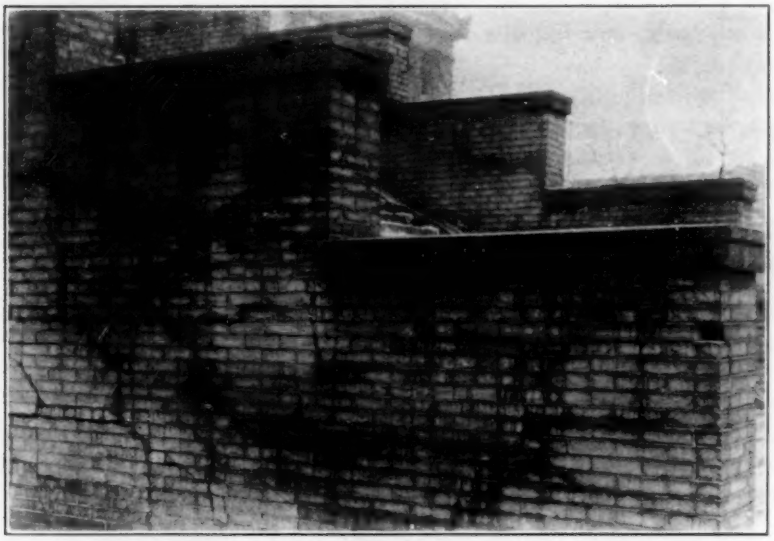

FIG. 2.—A curtain wall damaged by freezing. Had the coping been provided with a drip, had a waterproof membrane of some kind been placed between the coping and the brickwork, or had an air space been provided in the wall for drainage and ventilation, it is presumable that the wall would be in good shape today.

back the water, and when a wall of one of these kinds of brick becomes saturated, followed by freezing, considerable damage might be done, as illustrated in Fig. 2. Some experiments are being conducted on internal ventilation of the wall to try to take care of this situation.

The immediate absorption of the brick in contact with the mortar is a matter of importance, and depends upon the temperature and the nature of the mortar. When the mortar contains large amounts of lime or clay (bentonite) which hold considerable water, the brick can and should have quite a high absorption. With mortars richer in Portland cement, where the water is less tightly held, it is probably wiser to use brick of lower absorption.

Rules for Desirable Absorption of the Brick

In winter the viscosity of water is so much higher than in summer that the rate of absorption is greatly lowered, requiring brick of higher "sucking power." The width of joint must also be considered. With a one-inch joint, a more porous brick should be used than with a quarter-inch or tighter joint. For the latter in hot, dry summer weather, a ten-minute absorption rate of from 1 to 4% is probably best, depending upon the water-retaining power of the mortar. In cold, damp winter weather these values might be profitably doubled. For thick joints, this range should be doubled for summer work and quadrupled for winter work. These results have been obtained as a result of careful observation, and with the help of skilled mechanics. The details will be reported in full elsewhere.

TABLE I

Color	Per cent absorption			Modulus rupture (lbs./in.²)	Compressive (lbs./in.²)	Remarks
	10 min.	30 min.	24 hr.			
AH red	8.5	8.5	8.6	831		Soft-mud machined
AS red	12.3	12.6	13.3	354		Soft-mud machined
B red	6.4	7.4	7.9		5825	Dry pressed
C reddish yellow	1.4	2.7	6.7	770	5352	Stiff mud
DR brown spots	4.4	4.7	5.7	1270		Dry pressed
DP roman	3.0	3.0	3.8	1370		Dry pressed
E buff	1.6	2.2	7.0	1507	7100	Stiff mud
F white	0.6	0.9	2.3	1494	7792	Stiff mud
G dark red	2.1	2.7	4.4	Brick 2¾x8x8		Stiff mud

Mortar tempered to a consistency suitable for bricklaying is rather fluid, with a high water-cement ratio which needs to be reduced considerably, in order to allow the development of suitable strengths. On the other hand, if the absorption is too rapid, as with the AS brick, so much of the moisture is removed from the mortar in contact with the dry brick that the mortar congeals on coming in contact, has no chance to spread out evenly over the surface, has inadequate opportunity to make thorough contact, and bonds poorly. The obvious remedy is to wet the brick before using.

The Mortar

At least three chief variable factors enter into the mortar: the cementing material, the aggregate, and the ratio between the two. The thoroughness of mixing is also important.

Cementing Material The extremes probably are pure Portland cement mortar, on the one hand, and pure lime mortar on the other. Both have been used frequently but more often various mixtures of the two are used, while the several masonry cements on the markets correspond to various mixtures of the two; several samples tested seem to be similar to a mix made of 1 bag of lime with ½ to 1 bag of Portland cement.

Some results have been obtained on the compressive strengths of several of the mortars used, care being taken to make up the specimens so as to simulate as closely as possible the actual use in brick walls. For this purpose one-inch brass molds were used and were placed upon several different kinds of brick. Mortar was taken directly from the mortar board and filled into the mold. Another brick of the same kind was then used to compact the mortar and strike off the excess, finally being left in contact for 24 hours. This operation was carried out as nearly like the actual bricklaying operation as possible. The specimens were stored in water for 6 days and in the air of the laboratory for 21 days, and were then broken in compression. Usually two mixes, one leaner and one richer, were made up of each mortar in order to give two points in the range covered by practical users. The results tabulated are the averages of all those obtained with different kinds of brick. The strength seems to vary somewhat with the absorption of the brick.

TABLE II

MIX BY VOLUME

Cement : Lime : Sand				Masonry Cements			
Rich mix		Lean mix		Rich		Lean	
0:1:2.5	235	0:1:4.5	166	A 1:2	827	1:2.5	571
1:2:5.7	1009	1:2:10	624	B 1:2	1534	1:2.7	1059
1:1:5	1417	1:1:8.5	2000	C 1:2	1745	1:2.7	1278
2:1:5.7	2518	2:1:10	2339	D 1:2.5	2050	1:3.5	278
5:1:13	4012	5:1:22	3812	D 1:3	810	1:4	270
1:0:2	4324	1:0:3	4132				

Waterproofers

A	Cement 2:lime 1:sand 6	Cement 5:lime 1:sand 12
A	3696	3195
B	3195	3170
C		3112
D		3441

As the proportion of cement is increased, so is the compressive strength. The richer mixes give generally higher strengths than the lean mixes.

The waterproofers seem to lower the strength somewhat, but one can well afford this small loss for the sake of the increased water-tightness.

Sand As a preliminary to the erection of the panels, 16 sands obtained from 12 cities were tested.

The results of experiments made by this Fellowship, to be published shortly, have demonstrated the probable correctness of a theory according to which an ideal grading of a sand for mortar is one of a uniform increase in amount with the size of the sieve opening. Using a standard series of sieves, whose mesh sizes differ by a constant factor of 2, *e.g.*, 100, 48, 28, 14, 8, etc., the amount passing a given sieve and retained on the next smaller should be about 1.25 times that retained on the next smaller size

still. Such a grading makes a dense, strong mortar and also has quite good workability. In fact, experience has shown that such a grading is outstanding in the high ratio of workability to water requirement.

Of the several sands tested, that used widely in the New York district came fairly close to the ideal and gave best all round results. Because of this finding and because of the wide use of this material, it was chosen for the experiments.

Mix In practical work a wide variation in mix is apt to occur. Very often little or no control is exercised although the general tendency, if no supervision is exercised, is toward a rich mix to suit the demands of the brick mason. In this experimental work it would have been costly to vary the mix from very lean to very rich by steps; therefore a compromise was reached by selecting one mix a little rich and one a little lean, as judged by the masons. That gave two points in the rather wide range of mixes.

Workmanship

The factor of workmanship seems to be the most important in brick work, both in the cost and in the integrity of the wall. The bricklayer may be a highly skilled artisan who takes pride in turning out high class work.

The economic necessity of getting a reasonable number of bricks laid during the day, however, combined with a dearth of standards as to what constitutes proper bricklaying, has resulted in the brick mason developing a more or less faulty technique from which he departs only with considerable mental effort.

During tests on some of these panels for flexural strengths, the premature breaking of several have indicated points of weakness in the panels, which were ascribed to the tapping back of the brick into plumb. This tapping back breaks the bond between the mortar and the brick and the extent of renewal of the bond will depend upon the length of time between the setting and tapping back, and upon the absorbing power of the brick relative to the water-retaining power of the mortar. A series of panels built to study the question of tapping back into plumb has given positive indication of the danger of this operation to the integrity of the brick wall. The logical conclusion is that this is an important cause of the open horizontal joints found occasionally in brickwork.

The results obtained at the Bureau of Standards for the effect of joint filling on the compressive strength of brick panels have been partially substantiated in this investigation for the more important flexural strength. The practice of furrowing the mortar bed appears to result in a diminution of about 50% of the flexural strength as compared with solid joints. The extent to which the head joints are filled appears to have less effect on the flexural strength of the wall, at least where the bending force is in the

vertical plane. Nevertheless, the common method of spotting the end of the brick with a small amount of mortar seems to be the source of considerable leakage, according to the experience of several who have made a business of stopping leaking brick walls.

Design

The fourth of the main factors affecting brick walls is design, and a number of subfactors are under consideration, including differential volume change between the face and the backing, provision of air spaces for drainage and internal ventilation, coping problems, parapet walls, condensation, heat leakage, etc.

The contraction and expansion of walls, especially where different types of material are in contact, may be suspected as a cause of part of the trouble that has occurred in buildings. All materials are subject to the temperature changes, and mortar tends to expand on wetting and to shrink on drying.[4]

A large number of panels have been erected to see if a differential change between the face of the wall and the backing might develop. No positive evidence of such an effect has been brought to light, in the first six months of exposure, during which the greatest variation has been in moisture content. The effect of temperatures below zero and of the rapid changes of temperature characteristic of the month of April, have still to be determined.

The changes in volume of these panels have been followed with a 20-inch strain gage, and have been surprisingly small. The gage reads to 0.0002-inch and the maximum deflection between walls during the dry spell of last September and when saturated either by long spraying or by the heavy storm of October, was but 6 divisions. The usual reading was about 2 divisions, or 0.12 inch in 500 feet.

All the panels that were erected in the summer have been subjected to a spraying, observations being made on their water-tightness. Those walls made of Bricks C, D, E, and F, when provided with a water-tight mortar did not permit the water to pass, provided the joints, at least to a depth of an inch, were filled. Those mortars made of one special masonry cement, of a Portland cement containing an integral stearate water-proofer, or to which ammonium stearate paste was added in the mixing water, were tight under spraying or under a layer of impounded water. The ammonium stearate made a favorable impression, reënforced by other experience.

The thirty odd panels where the face was separated from the back by a small air space did not permit water to pass clear through even on

[4] Raymond Davis, *Proc. Amer. Concrete Inst.*, **25**, 218 (1929). The order of change for drying or wetting was given as being a few hundredths of 1%.

prolonged spraying. Those panels erected with Brick G, where the mortar was in contact with the outer edges only and where the center of the wall was a checker work of open spaces, also prevented the passage of the water clear through the panel. What happened was that the moisture passing through the face ran down the open spaces. These facts led to the following reasoning:

To get the face of the wall tight requires a good brick, a special mortar, and exceptional workmanship, a combination a little difficult perhaps to obtain. Even if secured, there is no assurance that the wall may not become soaked from, perhaps, a leaky gutter. Hence it might seem logical to provide an air space in the wall with suitable weep holes to stop the passage of water through the wall. This air space might have other valuable properties; it might have heat-insulating value and it might give a very useful internal ventilation to the wall. Its effect on air infiltration must also be considered.

The "breathing" at the surface of the wall, which means opportunity for moisture to evaporate, is very important if the wall becomes wet. Figure 2 shows what may happen when a wall, with a highly impervious surface, becomes soaked. Now a wall face of this type has so many points in its favor, including its freedom from griming, that efforts should be made to try to get around its intrinsic troubles by proper design.

In this case, and perhaps for parapet walls in general, the coping should be provided with a suitable drip; a sheet of some impervious material ought to be placed between the coping and the brick work; and finally, it seems logical to expect that an air space in the wall, together with suitable weep holes below and vent holes above, would provide an opportunity not only for drainage, but also for ventilation. An adequate internal ventilation may overcome the lack of breathing from the surface. A number of panels have been erected to try out these ideas. It is also planned to incorporate several of these in a house, the walls of which are to be a series of panels 6 by 5 feet, in which a number of methods of producing air spaces can be tried out. At the same time heat-flow and air-infiltration can be measured.

As the house will need a roof an excellent opportunity is provided for trying out several types of gutter construction. Judging from the large amount of disintegration, efflorescence, and staining, personally observed, and arising from gutters of faulty design or material, this is a point of considerable importance.

A number of other points in design might be mentioned, including the application of asphaltic preparation to reduce the penetration of moisture through the walls and the use of water-proof membranes at the spandrel beam. These will receive attention in due time.

In conclusion, it might be said that only by far-reaching team work

can tight brick masonry be built. The brick manufacturer should provide a brick that has the right range of absorption and that has the proper surface to bond well with the mortar. The producer of cement and lime must provide a cementing material which will (1) be suitably plastic to work well under the trowel, (2) adhere very tightly to the brick, (3) be sufficiently flexible to take up the buffets of the wind even in tower buildings, (4) be water-tight, and (5) of course, be reasonable in price.

The architect is an important member of the team, since by adequate design many of the troubles in walls of the present day may be eliminated. The engineer and contractor by insisting on good materials and good workmanship can be very helpful and, after all is said and done, it is necessary that the foreman and the brick mason himself do their work as perfectly as possible.

A NEW FORM OF NONPLASTIC MATERIAL[1]

By A. H. Fessler

ABSTRACT

This article indicates the results obtained by introducing into a porcelain mixture an unstable nonplastic aggregate, consisting chemically of alumina, silica, and a fluxing oxide, which latter has been heat-treated in such a manner that its crystallization has been arrested. Upon subsequent kiln firing, crystallization takes place and the arrested crystals grow, orienting themselves in such a manner as to form a network of interwoven crystals. The effect of this crystallization improves the physical properties of the porcelain.

Introduction

The desirability in porcelain mixtures of using nonplastic materials higher than calcined clay in alumina is known. Such nonplastic ingredients produce a porcelain having higher resistance to thermal shock and greater mechanical strength. Bruno Kerl reports that Hecht used to advantage an artificially prepared nonplastic ingredient in porcelain in which the nonplastic was composed of six parts by weight of Rakonitzer shale clay and one part of chemically clean alumina, which was fired to Seger cone 20 (2768°F). This calcined product was finely pulverized and used as a nonplastic.[2] Kerl also reports that the Royal Porcelain Factory of Berlin manufactured a porcelain of highly desirable properties to be used for all purposes where high temperatures are encountered. This porcelain mixture was rich in alumina and poor in silica and contained a small amount of fluxes including magnesia.[3] Zoellner reports that the formation of sillimanite in a porcelain imparts many desirable characteristics and its formation should be encouraged.[4] Bell records an increase in the resistance to thermal shock of porcelain composed of nonplastic and raw clay ingredients, in which the nonplastic content was composed in part of aluminum hydroxide. He reports attempts to increase the alumina content by the addition of Alundum which were not successful, probably due to the refractoriness and inertness of the Alundum fragments.[5]

Recent work, published in 1924, by Bowen and Greig of the U. S. Geophysical Laboratory indicates that the improved qualities of the porcelain which contained such nonplastic mixtures was probably due to the presence of the crystal, mullite, rather than the crystal known as sillimanite.

Present Status of Porcelain Compositions

More recent developments in the high-temperature porcelain industries

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division).

[2] *Handbuch der Gesammten Tonwarenindustrie*, 3rd ed., p. 1392 (1907).

[3] *Ibid.*, pp. 1392–93 (1907).

[4] *Sprechsaal*, 1907.

[5] *Trans. Amer. Ceram. Soc.*, 9, pp. 637 and 645 (1907).

have indicated the value of increasing the alumina content by incorporating a nonplastic ingredient composed mainly of some crystalline form of an aluminum silicate such as andalusite, mullite, cyanite, or dumortierite. These are usually incorporated in the raw batch as naturally occurring crystalline forms such as occur in nature, or as mullite properly developed by calcining or fusing a suitable mixture of alumina and silica.

Aluminum silicates such as are found in nature are usually completely crystallized and the crystals themselves are in a refractory form. The electric arc furnace product, mullite, is also in a stable and refractory form. These crystals, either occurring naturally or made synthetically when incorporated in the porcelain mixture, are very slowly attacked by the dissolving fluxes used to obtain vitrification in the firing process.

Microscopic examination of the porcelain containing such crystalline nonplastic ingredients indicates that the crystals show practically no growth and very little solution by the fluxes present. They appear to be held in the porcelain structure mainly by being imbedded in the ground mass formed by the dissociation of the raw clay ingredients. The slight solution or wetting of the edges of the crystals aids somewhat in holding these crystals in the porcelain structure. It would seem from this that probably the main value of such crystalline nonplastics is primarily that of a grog or inert material.

Naturally occurring cyanite, when incorporated in the ceramic mixture as such and fired, seems to be an exception to other crystalline forms of alumina silicates, in that the increase in volume which occurs in firing shatters the crystals offering an apparent advantage in some types of ceramic ware. If, however, the cyanite is calcined to a temperature sufficiently high to convert the cyanite into mullite before incorporating in the porcelain mixture, this effect probably is lost and the mullite crystals then function mainly as an inert material or grog.

The structure obtained by incorporating such materials as the nonplastic ingredients, does not indicate as homogeneous a structure as that obtained if the nonplastic is produced in such a manner that its crystallization has been either arrested or is in partly an amorphous form when embodied in the ceramic mixture and fired. During the firing process the nonplastic whose crystallization has been prevented or at least arrested, crystallizes and the arrested crystals grow forming a network of interwoven crystals. This crystallization seems to increase the porcelain resistance to thermal shock as well as to increase its mechanical strength.

Process of Making Unstable Nonplastic Material

To obtain a nonplastic material of the desired characteristic, it is necessary to completely melt the composition and then to cool with such rapidity that the molten material does not completely crystallize before its tempera-

ture is lowered to such an extent that it is impossible for further crystallization to take place. The amount of crystallization taking place, the temperature necessary for complete melting, and the character of the fused material depends upon the molecular ratio of alumina to silica, the kind and amount of fluxing oxide present, the amount of impurities occurring in the raw materials, and upon the rate of cooling. All compositions approaching the molecular ratio of 3 alumina to 2 silica with a reasonable amount of fluxes necessitates a temperature that is only economically obtained in an electric arc.

Character of the Quickly Cooled Materials

The quickly cooled material produced in the manner described consists of two phases, that is, a glass phase and an arrested crystalline phase. The per cent present of either phase again depends upon the same conditions that determine the other characteristics of the material. The additional factor of viscosity, however, seems to be an important factor in determining the quantity of the two phases present.

Glass Phase The glass when produced in the manner described holds in solution alumina and silica, the amount depending mainly upon the fluxing oxide present, upon the alumina to silica ratio, and upon the rate of cooling. The glass partially devitrifies or crystallizes during the final firing process and it is partly from this crystallization that the additional desirable structure and the characteristics of the porcelain are obtained. The glass remaining after crystallization has taken place is probably equal to the crystalline phase in its effect on the physical properties of the porcelain in which it is incorporated, and has apparently a very great influence on the impact and tensile strength, coefficient of thermal expansion, resistance to thermal shock, and electrical properties of the porcelain as well as on its vitrifying behavior. This is due mainly to the fact that most of the fluxing oxides added for vitrification as well as part of the impurities occurring in the raw materials remain in the glass. Exceptions to this statement are found in the use of certain fluxes which combine with alumina or silica or with a combination of these two to form solid solutions, but in all cases a sufficient amount of the fluxing oxide is present in the glass to have a large influence on the physical properties of the porcelain.

The Arrested Crystalline Phase This phase predominates in all compositions produced in this manner which are sufficiently high in alumina to have the molecular ratio of 3 alumina to 2 silica. The crystals vary in size in the compositions examined from crypto-crystalline up to considerably large, but in all cases were less than 1 mm. in length. An increase in the alumina content above the 3 to 2 ratio increases the amount of arrested mullite crystals until the composition is obtained in which the system becomes supersaturated in respect

to alumina, then corundum, spinels, or aluminates appear in the system. The amount of alumina that can be held in the system before crystallizing in these forms depends largely upon the amount and kind of fluxing oxide present.

It was observed by microscopic examination of the quickly cooled melts that an increase in the alumina content with a corresponding decrease in the silica content produces a quickly cooled nonplastic material in which the individual crystals are considerably larger and more perfectly developed than the crystals appearing in the compositions slightly higher in silica. This is no doubt due partly to the difference in viscosity of the melts, since it is known that siliceous compositions are more viscous than compositions higher in their alumina content. It is also indicated that the more perfectly developed crystals from the higher alumina compositions do not indicate as marked a growth in the final firing process as the crystals which are found in the compositions slightly higher in silica.

Effect of Vitrification

The firing temperature necessary to obtain vitrification of a porcelain body consisting in part of a quickly cooled nonplastic which is composed of alumina, silica, and a fluxing oxide, is considerably higher in most cases than the porcelain composed of a completely melted nonplastic material of the same chemical composition but produced in such a manner that its crystallization is complete before the final firing. This is probably due to the fact that the glass in the quickly cooled material holds in solution a greater amount of alumina and silica which necessarily makes the glass more refractory than the glass from which crystallization has taken place to the extent that is found in slowly cooled products. This is exemplified by one slowly cooled composition examined whose glass was found to have an index of refraction of 1.52, while the same composition produced in such a manner that the fused material was quickly cooled had an index of refraction of 1.58. This increase in the refractive index of the glass indicates that considerable alumina was held in solution in the quickly cooled melt.

The effectiveness of the flux ingredients as solvents was increased by this premelting process since it was observed, in comparing the vitrification temperature of porcelain embodying the unstable material with the same composition introduced as calcines, that the bodies containing the calcines required a higher vitrification temperature. This difference in temperature varied with the composition of the nonplastic material.

The importance of the correct firing schedule is very apparent in firing porcelain compositions composed in part of a quickly cooled fused material, as it has been found possible to improve the physical properties of the porcelain considerably by a firing schedule that permits the desired amount of

crystallization to take place from the unstable nonplastic ingredients. If the firing schedule is too rapid, the nonplastic material does not have sufficient time to crystallize completely before its viscosity is increased to such an extent that crystallization cannot proceed. This condition is not conducive to producing porcelain of the most desirable characteristics.

Effect of Unstable Nonplastics on Physical Properties of Porcelain

To determine the effect on the physical properties of porcelain by incorporating unstable nonplastic material, the test values obtained were compared with the values obtained by incorporating calcines of the same composition. From these tests it is indicated that the composition of nonplastic material determines to a large extent the advantages that are obtained by the use of such materials. Compositions having a higher silica content than is found in the molecular ratio of 3 alumina to 2 silica are more effective in increasing the test values than are the compositions with a lower silica content. This is partly due to the fact that the higher alumina compositions are more stable. The more unstable compositions indicated that more crystallization had taken place in the subsequent firing and thus a greater increase in test values was obtained.

Conclusion

A method is indicated for producing unstable nonplastic materials which, when incorporated in a porcelain batch and then fired, produces porcelain of more desirable characteristics than porcelain obtained by incorporating calcines as the nonplastic material. The structure obtained by firing the porcelain embodying such unstable material is probably mainly responsible for these increased test values. The mechanical test values and the resistance of the porcelain to thermal shock indicate the most increase. The percentage increase depends primarily upon the composition of the nonplastic material although all compositions tested seemed to indicate values that recommend the use of unstable nonplastic materials.

This method of preparation and the resultant product obtained are recommended for those industries in which such increased test values would justify the increased cost of preparation of such nonplastic materials.

A C Spark Plug Company
Flint, Mich.

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THE EFFECT OF DIFFERENT FLUXING OXIDES ON THE CONSTITUTION OF PORCELAIN[1]

By A. H. Fessler and Hans Navratiel

ABSTRACT

This article deals in a general way with the constitution of siliceous porcelain. The influence of the different fluxing oxides on the formation of the glass phase is indicated by solubility and specific gravity determinations as well as by microphotographs.

Introduction

Porcelain consisting of approximately 50% clay substance, 25% quartz, and 25% orthoclase feldspar, which has been fired several times to approximately Seger cone 16, is a physical mixture consisting of approximately 70% glass, 30% crystals, and considerable gas voids. Microscopic examination of such a porcelain indicates that the crystalline phase is composed mainly of mullite, with some quartz, although recently X-ray investigators have suggested the possible presence of cristobalite and tridymite. This microscopic examination, however, does not indicate the quality of the glass phase of the porcelain although such an examination may indicate the quantity, form, kind, and distribution of this phase. The glass phase occurring in porcelain is not homogeneous, but seems to be a series of glasses, the composition of which depends upon the various concentrations of the ingredients of the body.

A finely ground mixture of approximately 50% orthoclase feldspar and 50% quartz which has been melted at Seger cone 16 and then cooled, is composed entirely of glass. Microscopic examination of such mixtures with a quartz content of over 50% under high-powered lens, between crossed-nicols and with a mica plate, indicate a faintly birefringent crystal. It is with difficulty that these crystals are absolutely identified microscopically since they have an index of refraction of approximately 1.470, which is practically the same index as the glass in which they are found. It is reasonable, however, to assume that these crystals are either cristobalite or tridymite.

In the firing of porcelain, the eutectic mixture and feldspar are the first to become fluid and are able to dissolve increasing amounts of the products resulting from the dissociation of clay substance. The aluminous phases resulting from this dissociation are dissolved to a lesser extent than is the silica. It has also been indicated by previous investigators that orthoclase feldspar is able to dissolve approximately 20% of its weight in clay substance before mullite appears in the system. Navratiel found, however, that if the quartz content is increased, the feldspar is not able to dissolve the same amount of clay substance as before but only approximately

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division).

one-half of this amount.[2] Figure 1 presents Prof. Eitel's theoretical explanation of this fact. Schwarz and Merk[3] confirmed this result at a later date and Parmelee and Amberg[4] have reviewed the literature pertaining to this subject in their recent article.

Present Investigation

Object The formation of the glass phase in porcelain seems to be influenced by several fundamental properties of which the chemical character, melting range, viscosity, and speed of crystallization are probably of the most importance in controlling the stability of the glass formed in the firing process. It would seem that all oxides should vary in their effect on these properties and that they also should vary in their ability to form stable glasses in porcelain. The published equilibrium diagrams do not indicate this phenomenon which is of considerable interest to all ceramic technologists.

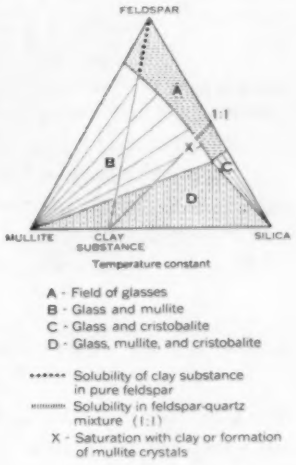

FIG. 1.

From the reactions that have taken place in firing hard siliceous porcelain to a state approaching equilibrium we might expect to obtain glasses of the following general formula: $RO–Al_2O_3–xSiO_2$. To determine the numerical values for this formula it is necessary to determine the largest amount of silica that these fluxes in the form of artificial feldspars are able to hold in solution before crystallization takes place under certain fixed conditions. For this reason the following experiments were undertaken.

Preparation of Samples One molecular equivalent of each of the following fluxing oxides of the first two series of the periodic system was introduced into the mixture as a carbonate. Each flux was thoroughly mixed with one molecular equivalent of calcined Al_2O_3 and the maximum amount of SiO_2 was determined which would entirely form glass under conditions as nearly uniform as possible. The preparation of these samples consisted in weighing and placing in platinum crucibles the carefully mixed dry ingredients. These samples were fired to Orton

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[2] Dissertation by Hans Navratiel as partial fulfillment of the requirements for the degree of Dr. Ing, University of Charlottenburg, Berlin, Germany, February, 1925.

[3] *Z. anorg. allgem. Chem.*, **156**, Parts 1 and 2, 1926.

[4] C. W. Parmelee and C. R. Amberg, "Solubility of Quartz and Clay in Feldspar," *Jour. Amer. Ceram. Soc.*, **12** [8], 699–710 (1929).

cone 17 on a fifteen-hour schedule, remaining in the hot zone of the furnace for approximately four hours while the temperature was increased from 1300 to 1470°C. These samples were fired four times and after each of the first three the mixtures were crushed to a fine powder so that they could more readily reach equilibrium in the subsequent firing. After the final firing each composition was examined under the petrographic microscope to determine the beginning of crystallization.

Results The fluxing oxides seemed to arrange themselves in the order as indicated in Table I in their ability to hold SiO_2 in solution:

TABLE I

	Molecular weight	Molecular formula			Percentages by weight			5 g. of RO taken into solution		Grams of glass
		RO	Al_2O_3	SiO_2	RO	Al_2O_3	SiO_2	Al_2O_3(g.)	SiO_2(g.)	
Stable alkali glasses	30	Li_2O	1	12	3.5	11.9	84.5	17.0	120.7	142.7
	62	Na_2O	1	14	6.1	10.1	83.5	8.3	68.4	81.7
	94	K_2O	1	15	8.6	9.3	82.1	5.4	47.7	58.1
	187	Rb_2O	1	22	11.6	6.35	82.0	2.7	35.3	43.0
	280	Cs_2O	1	28∼	13.7	4.9	81.5	1.8	29.7	36.5
Stable earth-alkali glasses	25	BeO*	1	3∼	7.0	26.0	67.0	18.6	47.9	71.5
	40	MgO	1	4	10.4	26.7	62.8	12.8	30.2	48.0
	56	CaO	1	7	9.6	17.6	72.8	9.2	37.9	52.1
	104	SrO	1	8	15.2	14.9	70.0	4.9	23.0	32.9
	153	BaO	1	9	19.2	12.8	68.0	3.3	17.7	26.0

* Did not obtain 100% glass with this formula, but obtained the most glass of all the BeO mixtures within the temperature range investigated.

It is indicated from Table I that the oxides may be divided into two groups, one group for the alkalis and the other for the alkaline earth fluxes. This division is made possible by the fact that the oxides differ in the amount of silica that one molecular equivalent is able to hold in solution before crystallization appears, and this amount increases with an increase in the molecular weight of the oxides.

It would also seem that the alkalinity of the oxides has considerable effect since an increase in the alkalinity coincides with the ability of the oxides to take silica into solution. This solubility is also expressed in weight percentages of the ingredients and indicates that lithium oxide is able to produce the greatest amount of glass with the least amount of flux.

Specific Gravity

We should expect in different sections of every system to obtain glasses of different compositions. For instance, with a composition of 95% kaolin and 5% fluxing oxide, we should obtain different glasses than those obtained in the compositions used in the solubility experiments. To investigate this as well as the amount and theoretical composition of these glasses, specific gravity determinations were made.

Preparation of Samples Approximately 250 grams of thoroughly dried and mixed ingredients were fused in an electric arc furnace. These compositions consisted of 95% electroösmose clay and 5% by weight of each of the fluxing oxides listed in Table I. The fused materials were quenched and part of the samples devitrified at cone 17 on a fifteen-hour heating schedule to obtain samples for the determination of the specific gravity values. By this means, equilibrium is approached sooner than by calcining the mixtures several times. The specific gravity measurements of both the fused and devitrified materials were obtained by the pycnometer method according to the process advocated by the Standard Test Committee of the AMERICAN CERAMIC SOCIETY.

Results Microscopic examination of the fused and quenched materials indicates glass as the only phase, while the devitrified composition indicated the presence practically of only glass and mullite. In the melt containing lithium oxide, eucryptite was identified in such amounts as to eliminate this melt from the specific gravity determinations. It was also possible that in a few of the melts some free silica or aluminum silicates other than mullite appeared in the melts which would influence the specific gravity measurements. The amount of these other crystalline phases, however, was not sufficient to affect these results appreciably.

TABLE II
SPECIFIC GRAVITY VALUES

Composition 95% osmose clay plus 5%	Amorphous	Devitrified	Difference
Li_2O	2.49		
Na_2O	2.53	2.66	0.13
K_2O	2.535	2.676	0.141
Rb_2O	2.55	2.73	0.18
Cs_2O	2.60	2.79	0.19
BeO	2.56	2.78	0.22
MgO	2.57	2.75	0.18
CaO	2.57	2.72	0.15
SrO	2.59	2.77	0.18
BaO	2.62	2.80	0.18

Table II indicates the effect of the density factor of the oxides as found by Winkelmann and Schott, on the specific gravity values.[5] An increase in the density factor indicated an increase in the specific gravity values.

From the specific gravity values of the amorphous as well as of the devitrified samples which are plotted in Fig. 2, the approximate amount of mullite which has crystallized is calculated. This calculation is made assuming that the differences in the specific gravities between the amor-

[5] Hovestadt, Jena Glass and Its Scientific and Industrial Application, p. 149. Published in 1902.

phous and the devitrified materials are practically entirely due to the formation of mullite.

A slight error is introduced in these calculations since no allowance is

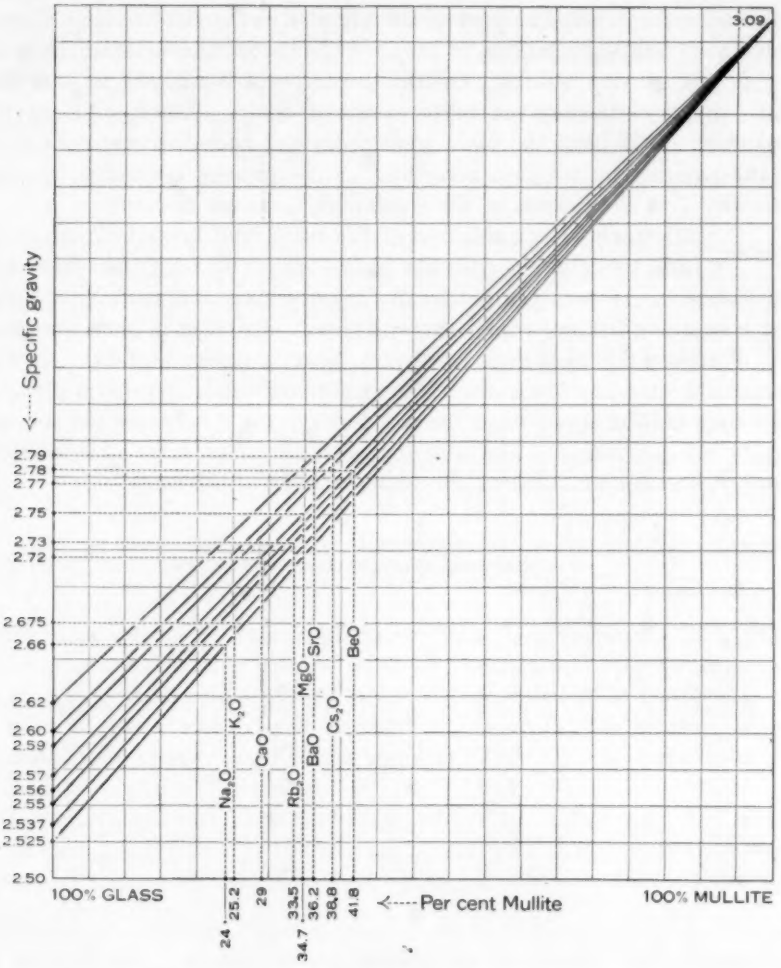

FIG. 2.—Graphical calculation of glass and mullite content by specific gravity determinations.

made for the specific gravity of the glass remaining after crystallization has taken place.

It is to be noted from this figure that weight for weight, BeO forms the most mullite and the least amount of glass, while sodium forms the most glass with the least amount of mullite. The approximate composition of

the remaining glass may be calculated from the data as given by this figure since the original composition of the mixture is given.

Figure 3 shows the location of glass compositions found from the solubility determinations as well as the glass compositions calculated from specific gravity determinations. It is to be noted that the glasses obtained by these two experiments are located in different areas with the exception of BeO and MgO, the glass areas of which fall very closely together. The glass compositions obtained from the solubility determination appear to be stable but the glasses calculated by the specific gravity determinations are only theoretical and the stability of these glasses was not investigated although stable glasses could be expected in approximately this section.

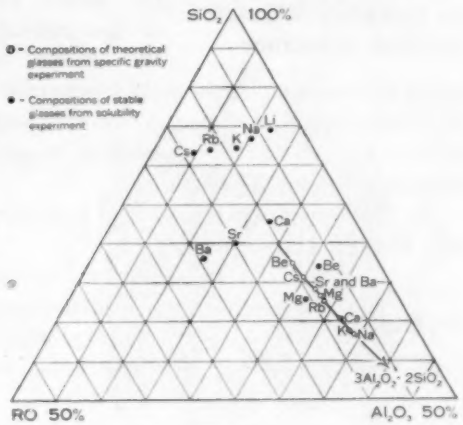

FIG. 3.

Effect of a Few of the Oxides on the Structure of Porcelain

To show the effect of a few of the fluxing oxides on the structure of siliceous porcelain, the following microphotographs were taken under the same photographic conditions, with a Leitz microscope with a magnification of approximately 840.

Figures 4, 5, 6, and 7 were taken in ordinary light and represent porcelain composed of 50% Zeitlitz kaolin, 25% Hohenbockaer quartz, and 25% flux. This flux composition was of the general formula $RO–Al_2O_3\ 6SiO_2$, which is of the general type of composition as covered by the solubility experiments.

Figures 8 and 9 were taken between cross-nicols and represent porcelains of the composition of 50% plastic clay mixture and 50% of nonplastic material. The nonplastic material was composed of 95% Georgia kaolin and 5% of the different fluxing oxides which compositions had been fused in the electric arc furnace. These porcelain mixtures are similar to the composition used in the specific gravity experiments.

Results The microphotographs clearly indicate differences in the structure of these porcelains which substantiate the results arrived at from data obtained by the preceding experiments.

Conclusions

It must be appreciated that in making experiments of this kind volatilization of the ingredients and nonuniformity of the firing conditions affect

considerably the final results, although chemical analyses were made to check the fused material containing the most volatile of the oxides used, and corrections in the compositions were accordingly made. The firing conditions were also kept as nearly constant as possible to eliminate possible variations from this source. The field covered in this investigation is limited and it is not possible to predict from these experiments the results to be obtained using compositions in other sections of the systems. The following conclusions, however, may be drawn and in order to clarify these results the summary is divided into four parts:

(1) Effect of Feldspar on the Solubility of Quartz and Clay Substance

(*a*) It is indicated under given conditions in the binary system, clay substance-feldspar that an increase in the silica content decreases the amount of clay substance that can be taken into solution before mullite is formed. It would seem from this, under the conditions as specified in porcelain compositions which are composed of feldspar and clay substance, that by adding silica the amount of mullite formation should increase.

(*b*) Microscopic examination of high silica melts indicates the presence of cristobalite and tridymite.

(2) Solubility Experiments

(*a*) These determinations indicate that each fluxing oxide differs in the amount of alumina and silica which it is able to hold in solution.

(*b*) The alkali group of fluxes holds more SiO_2 in solution than does the earth-alkaline group.

(*c*) The amount of silica held in solution increases with the alkalinity of the oxides when expressed in terms of molecular weights.

(*d*) There seems to be a systematic arrangement according to the periodic system in the order that the fluxing oxides arrange themselves when expressed in terms of molecular weights in their ability to hold alumina and silica in solution and to form stable glasses.

(*e*) In expressing these results in terms of per cent by weight, it is indicated that the same arrangement was found as was obtained by expressing these results in terms of molecular weights with the exception of MgO and BeO, which two oxides seem to form a special group.

(*f*) In expressing these results in terms of 5 grams of each of the oxides, the influence of the molecular weight of the oxides results in the following arrangement, since each fluxing oxide in the list forms more glass than the preceding oxide, BaO, SrO, Cs_2O, MgO, Rb_2O, CaO, BeO, K_2O, Na_2O, and Li_2O. BeO and MgO indicate the most variation from the arrangement found when expressing the results in molecular terms.

(3) Specific Gravity Determinations

(*a*) Specific gravity experiments indicate that in general the glasses formed in these experiments are not located in the same area as are found the

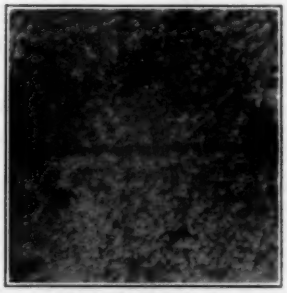

FIG. 4.—Flux = $CaO \cdot Al_2O_3 \cdot 6SiO_2$ ordinary light.

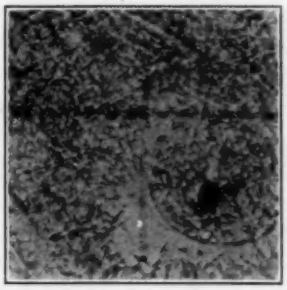

FIG. 5.—Flux = $Li_2O \cdot Al_2O_3 \cdot 6SiO_2$ ordinary light.

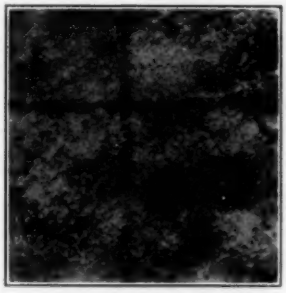

FIG. 6.—Flux = $BeO \cdot Al_2O_3 \cdot 6SiO_2$ ordinary light.

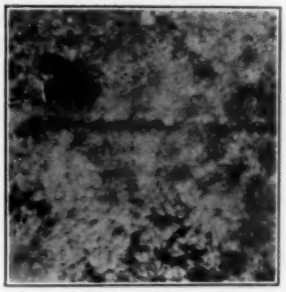

FIG. 7.—Flux = $MgO \cdot Al_2O_3 \cdot 6SiO_2$.

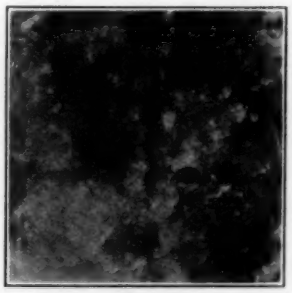

FIG. 8.—Nonplastic = 2.5% K_2O–97.5% kaolin between crossed-nicols.

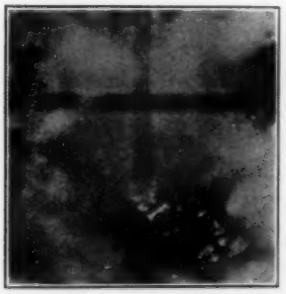

FIG. 9.—Nonplastic = 2.5% BeO–97.5% kaolin between crossed-nicols.

glasses from the solubility experiments with the exception of BeO and MgO glasses, which seemed to be located in practically the same area for both experiments.

(*b*) Graphical calculations were made of the amount of mullite that 5 grams of each of the oxides with kaolin are able to form. This calculation indicates that the amount of glass increases according to the following arrangement of the oxides: BeO, Ca_2O, BaO, SrO, MgO, Rb_2O, CaO, K_2O, and Na_2O.

(*c*) Compositions made under the conditions as specified indicate that all of these fluxing oxides decrease the amount of mullite which can be formed.

(4) Microphotographs (*a*) The microphotographs indicate that the fluxes affect the structure of the porcelain in accordance with the results obtained by the preceding experiments.

(*b*) The type of mullite formation varies with the flux which indicates that other factors such as viscosity affect the constitution of the porcelain.

A C Spark Plug Co.
Flint, Mich.

SOME RESULTS OBTAINED THROUGH THE USE OF BORAX IN THE MANUFACTURE OF TANK GLASSES[1]

By D. D. Schurtz

ABSTRACT

In the manufacture of various types of tank glasses, the introduction of a moderate amount of borax is becoming the general practice. Increased furnace production, less checking in fabrication, better finish, and more durable ware are indicative of its use. The introduction of borax and some of the problems connected with it are discussed.

Introduction

The use of borax in heat-resisting glass is quite well known and there are considerable data recording the effect of borax in this type of glass. Large batch additions, however, are necessary in a heat-resisting glass and practically all the published data deal with the additions of borax and boric acid large enough to give a glass containing between 5 to 20% boric oxide. A few manufacturers of tank glass have in the past used small additions of borax, but these were seldom over fifteen pounds to the ton sand batch, which would not give over 0.2% boric oxide in the finished glass. They may have gained a slight improvement in luster, but it is doubtful if there was any other noticeable benefit. Practically nothing was known regarding the effect of boric oxide on glasses in the range between 0.2 and 5% when the work to be described was started, a little over two years ago.

At that time the American Potash and Chemical Corporation requested that an investigation be made for them to study this unknown range and to determine whether moderate additions of borax in this range would be of sufficient benefit to justify its use in ordinary tank glasses. By ordinary tank glasses are meant those composed of sand, soda, lime, and possibly feldspar as commonly used in the manufacture of bottles and pressed and blown ware.

The Investigation

At Hocking Glass Co. The first experiment was conducted on an industrial scale at the Hocking Glass Company, Lancaster, Ohio. Through the courtesy of this company, a fifty-ton side port tank was placed at our disposal, and it must be mentioned that the coöperation and patience of this Company through the difficult period of preliminary tests were large factors in the successful results finally gained.

Borax Additions At the time, the tank was being operated with an ordinary batch composed of sand, soda, lime, and feld-

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Glass Division). Received March 3, 1930.

spar. Melting temperatures varied from 2625 to 2675°F, and in the test run these same temperatures were maintained. To the above batch, borax was gradually added. Fifteen pounds per ton sand batch were used at the start and slowly increased until at the end of thirty days sixty pounds had been introduced. Over the same period of time, the soda was cut thirty pounds. After several months the borax was gradually increased to one hundred pounds, with a further cut of twenty pounds of soda. With each addition of borax, there was a decided improvement in luster until sixty pounds had been introduced. Adding more than sixty pounds of borax further improved luster, but the effect was not so pronounced.

Pull of Tank The tank in which this batch was introduced was designed to deliver fifty tons of glass per day. Past experience had proved that it could be pulled sixty tons, but beyond this there were seeds and plenty of them. After the introduction of sixty pounds of borax, a heavy pull was applied and it was discovered, in due course of time, that an overpull much greater than any time heretofore was effected before seeds became a serious problem. After the addition of one hundred pounds of borax a further increase in overpull was accomplished, with like results. In the meantime, a similar batch was introduced in a second tank, then a third and fourth, and in each case the results were similar to those obtained in No. 1 furnace.

Since that time borax has been introduced in a great number of plants, and where the furnace conditions were at all favorable, heavy overpulls were possible. In a few cases, the overpulls were as high as 80%, and overpulls of from 25 to 50% have been quite common.

Quicker Plaining From the foregoing, one is led to believe that borax is a better flux, but quicker plaining plays an important part. From the feel of the glass in the doghouse after the introduction of borax, the increase of fluidity is striking. This would indicate that increased fluidity and possibly lower surface tension allows the more rapid escape of gases.

Better Feeder Operation As the quality of tank glass is dependent on so many different factors, it is necessary to generalize somewhat when describing results obtained through the use of moderate amounts of borax. In the original experiment, the glass contained about 8% lime (calcium plus magnesium oxide) and about 1.5% aluminum oxide. With the introduction of about 1% boric oxide, the resulting glass seemed ideal for feeder operation. There was a marked improvement in distribution and much less checking. In the manufacture of articles that required after-finishing, there was a general lessening of breakage. This was particularly noticeable when several operations were required in finishing.

Fewer Defects The general appearance of the ware was much improved. There were fewer surface defects and those that remained were partly obscured by the increased brilliancy. With the increased furnace pull, it was possible to make an appreciable cut in the decolorizer. This lightened the color and further improved the appearance of the ware.

Greater Durability The durability of the glass has also been improved to a marked extent as shown both by laboratory tests and by reduced bloom in actual storage. Solubility tests made on powdered samples by a method similar to that described by Dr. Peddle show reduced solubility compared to the same glass before introduction of borax. The difference in solubility of the powdered samples is not as marked as the difference in behavior under the autoclave test, however, and would not seem to explain the marked improvement in durability noted under commercial conditions. Some of the autoclave tests, on the other hand, show differences so striking as to indicate that moderate amounts of borax increase the resistance of the surface much more than that of the interior of the glass.

Data recently published in the *Glass Review* and elsewhere indicate that both the durability and the strength of glass are increased if the surface is smooth and perfect and are greatly decreased if there are any flaws at the surface. We do not have conclusive proof, but there are many striking indications that an important effect of the borax is to make the surface of the glass smoother and freer from minute imperfections than a similar glass without borax. This may in part account for the fact that in many cases improvement in durability and improvement in strength has been found to be considerably greater than would be expected from measurements of the solubility and thermal expansion of the glass as compared with a similar borax-free glass.

Greater Strength In determining the strength of containers by means of a hydrostatic tester, a real response has been shown through the use of borax, but no improvement if operating conditions are not right. This indicates the part furnace and machine operations play in the manufacture of good ware. Selecting two lots of bottles in one plant in which borax had been introduced, and applying the hydrostatic test, the bursting pressures of one lot ranged from 160 to 225 pounds, the majority breaking at 180 pounds. The second lot, made from glass containing borax, burst at pressures ranging from 200 to 300 pounds, the majority breaking at 225 pounds. Bottles from both lots contained practically the same amount of silica, lime, and alumina, and the results indicate that when factory conditions are favorable there is a marked improvement in strength after the introduction of a fair amount of borax.

Better Control of Color As borax is a good flux for most of the metal oxides, its application in the manufacture of colored glasses is obvious. It is especially useful in the manufacture of one colored glass which is hard to control, especially in those plants equipped for feeder operation. This colored glass is emerald green suitable for dry ginger ale bottles. These bottles have a tendency to run cordy and the prevention of these cords has been a problem. The use of borax in such glasses has been beneficial, especially in certain plants, and it has been found that if the feeder trough is of the proper design, a batch containing one hundred pounds of borax to the ton sand usually produces a glass ideal for emerald green bottles.

No Increase in Furnace Repairs During the past two years many furnaces that have been run on borax batches have undergone their first and second repairs and there has been no indication that borax, in the amounts stipulated, reduces the life of a furnace. The furnace life has been practically normal, and, although in a few cases it has been slightly less than the average of previous runs, it must be remembered that greatly increased amounts of glass have been pulled from these furnaces in this period. The tendency, therefore, has been for reduced furnace cost per ton of glass.

Increase in Melting and Refining Rate Last year, W. E. S. Turner in a systematic manner, conducted a series of experiments on a laboratory scale.[2] The results of his investigation may be summed up briefly by stating that in glasses of the soda-lime-silica and soda-lime-alumina-silica types the effect of introducing progressively increasing amounts of crystallized borax in batches brings about a notable increase in melting rate and a distinct improvement in refining rate. The resistance of such glasses to the action of water is generally improved and thermal expansion also is reduced. The results of Dr. Turner's work check well with the results we previously obtained on an industrial scale.

Effects Independent of Batch Composition When the work was begun there was some question as to whether it would be necessary to develop special batch formulas for use with borax. It has been our experience, however, that the beneficial effects of borax are to a considerable extent independent of the composition of the glass. Similar relative improvements have been gained in glasses with high calcium lime and with dolomite lime and in glasses with and without feldspar. Although it is obvious that the final properties of the glass must depend to a great extent upon all the constituents, the borax

[2] V. Dimbleby, M. Parkin, W. E. S. Turner, and F. Winks, "The Effect of Boric Oxide on the Rate of Melting and on Some Physical Properties of Colorless Bottle Glasses," *Jour. Soc. Glass Tech.*, **13** [51], 248 (1929).

seems to yield improvements along the lines which have been noted, irrespective of the batch to which it is added. Of course, the best results have been secured through the use of certain batches. They may be classed as those containing both calcium and magnesia as well as feldspar. Where furnace production and quality are to be considered, glasses containing approximately 73.5% silica, 2% alumina, 8% calcium and magnesium oxides, and 1% boric oxide, should be satisfactory to meet most requirements. It has ordinarily been our practice when introducing borax to cut the soda in amounts equivalent to one-half of the weight of the borax introduced. This substantially reduces the soda content in the finished glass. In cases where durability is of prime importance and furnace production can remain normal, the soda can be replaced by borax, pound for pound.

Conclusions

From the foregoing, we do not wish to leave the impression that borax is a "cure-all." Many problems have been connected with its use, and it might be well to cite one that caused considerable worry in the original experiment. After the introduction of thirty pounds of borax, there was a marked increase in fluidity, which allowed the batch pile to move with greater velocity, and as the percentage of borax was further increased, some of the batch escaped the hotter zones before it had entirely fluxed away. This, of course, caused seeds. By adjusting our mode of filling, and at the same time adjusting fires without altering temperatures, the glass quickly cleared, and it was after this correction it was discovered that abnormally high pulls could be applied without the development of seeds.

Furnaces are like human beings, there are never two alike. Furthermore, no two plants operate alike, so naturally many problems have been encountered. Many of these have been solved but a few remain to be answered and new ones may present themselves. From what has been accomplished, however, it is thought that the use of a moderate amount of borax in the manufacture of the more common tank glasses will continue, for as far as the manufacturer is concerned, the properties of borax are in the right direction. It tends to improve melting, reduce factory breakage, increase luster, durability, and strength, and in some cases these improvements have been striking. In a period of a little over two years, the industry has taken up borax to such an extent that at present it is being used in the manufacture of bottles of all kinds and descriptions, both flint and colored, and in tableware, both pressed and blown. Recently tests were started on an industrial scale in both the plate and sheet glass industries which indicates its possible adoption in a field that has been very conservative in accepting anything new that would change the composition of the product.

THE SHARP-SCHURTZ COMPANY
LANCASTER, OHIO

ACTION OF THE DUST FROM THE BATCH ON THE CHECKER BRICK OF GLASS FURNACE REGENERATORS[1]

By D. S. Beliankin[2] and M. A. Besborodov[2]

ABSTRACT

The crusts and glazed slag formations due to the glass batch dust that is carried by the gas current beyond the pots into the regenerators, flues, and burners were examined microscopically by X-ray and chemical analysis. Crystals of nepheline, carnegieite, and mullite are noted. This paper deals with the crusts and glazed surfaces in the regenerating chambers of two different pot furnaces.

Introduction

When the batch is introduced into the pots some of its particles are carried by the smoke gases a distance from the pots depending on their weight and on the rate of the gas current. The lightest particles are carried far; they get into the burners, the chambers of regenerators, and into the flues, and some probably are drawn into the chimney. The heavier particles, on the contrary, usually fall just beyond the pot but some succeed in getting as far as the burners and subside here and there on the hearth of the furnace. These particles of the batch react with the materials onto which they settle. Thus different parts of the furnace are slagged with glasses of different constitutions.

Some of these new formations have been described as follows: (1) the products of the corrosion of the vault by the dust from the batch rising to the top of the furnace and reacting with the blocks;[3] (2) the white spongy formation on the hearthstone of the pot furnace;[4] (3) the stalactites on the arch of the burner that covers the gas and air ducts.[5]

This paper deals with observations of slag formations in more remote parts of the furnace, *e.g.*, in the chambers of the regenerators.

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Glass Division). Received December 16, 1929.

[2] Mineralogical Laboratory of the Polytechnic Institute in Leningrad and Laboratory of the Glass Works, Drushnaya Gorka.

[3] M. A. Besborodov, "An Example of Decomposition of Fire Brick in Ovens for Glass Melting," *Keram. Rundschau*, No. 32, pp. 515–16 (1927); *Ceram. Abs.*, **6** [12], 569 (1927); *Jour. Soc. Glass Tech.*, **11** [44], 370–71 (1927); *Trans. Ceram. Soc.* [Eng.], **26** [4], 3 (1927) (abstract); *Glastech. Ber.*, No. 4, pp. 212–13 (1928).

[4] D. S. Beliankin and M. A. Besborodov, "Different Formations in a Glass-Melting Furnace," *Keram. Rundschau*, Nos. 23 and 24 (1929); D. S. Beliankin and M. A. Besborodov, about two kinds of formations from glass furnaces of the glass works "Drushnaya Gorka," *Keramica i Steklo*, No. 5, pp. 174–77 (1929).

[5] D. S. Beliankin and M. A. Besborodov, "Formation, Structure, and Origin of Stalactites in the Burner of the Glass-Melting Furnace," *Keram. Rundschau*, pp. 30–31 (1928); *Jour. Soc. Glass Tech.*, **12** [47], 220 (1928); *Glastech. Ber.*, No. 11, pp. 656–58 (1929).

The regenerating chambers of two types of pot furnaces at the glass works, Drushnaya Gorka, were investigated: (*a*) oval furnaces and (*b*) horse-shoe shaped furnaces. All of them had horizontal burners and a heat supply from the top.

Regenerating Chambers in Oval Furnaces

As one of these furnaces, No. 2, was being repaired, there was discovered on the walls of its air chamber a gray sintered layer. It could be rather easily removed from the brick. This layer was 1 cm. thick and covered like a crust the side walls of the chamber (see Fig. 1).

About ten years before this examination the walls of that chamber had been covered with a coating of fire clay, whose origin and composition are not known. Evidently, the dust from the batch reacted with this coating, producing a crust-like mass.

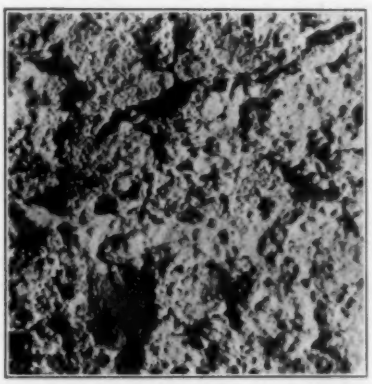

FIG. 1.

A microscopic investigation of this mass showed that its principal mineral components were alkaline alumino-silicates such as: (1) hexagonal nepheline, and (2) a pseudo-cubic optically anomalous mineral with a complicated lamellar twinning like that of leucite. Its index of refraction is 1.505 ± 0.014, which can apply to leucite (n_g = 1.509, n_p = 1.508) as well as to carnegieite (n_g = 1.514, n_p = 1.509, according to Bowen). The double refraction, however, is stronger than that of leucite; it is nearer to the mean of carnegieite. The possibility of the simultaneous presence of both these minerals must not be excluded. Conditionally the pseudo-cubic mineral will be called "carnegieite." This is not as unlikely in the sample which was examined as it was in the case reported by Insley,[6] who describes carnegieite in new formations on fire clay as having a refraction, n 1.533 ± 0.005. Small bi-pyramidal or needle-like crystals of rutile penetrated both the nepheline and the carnegieite. In one of the slides prepared by the authors these minerals are present almost alone. The nepheline forms short prisms, their size being more or less constant, about 0.025 mm.^{2} in cross-section. The carnegieite has developed in rounded grains of about the same size. Both crystallizations are independent of one another (Fig. 2). The nepheline contains more rutile than the carnegieite.

[6] H. Insley, "Some Observations of Surface Deposits Formed in Glass Furnace Regenerators," *Jour. Amer. Ceram. Soc.*, 9, 635–38 (1926).

In the other slide, though the nepheline and carnegieite are largely developed, there is some mullite. The carnegieite forms large crystals, which sometimes occupy the whole field of the microscope, even with a low power. The nepheline, contrary to the first slide, is observed not so much in idiomorphic crystals as in fine-grained aggregates, whose structure resembles that of the quartz hornstone. The nepheline aggregates appear first in small interstices separating the lumps of clay, but as they develop they spread out, substituting the clay lumps. Outside of the cracks the nepheline aggregates sometimes penetrate into the fields of carnegieite. In this case they seem partially to replace the carnegieite.

Combined with the nepheline aggregates larger and more homogeneous crystals resembling orthoclase are sometimes found. They are water-like, transparent, and have a pronounced cleavage in two reciprocally-perpendicular directions. In sections with cracks of both cleavages, the polarization is slight and there is shown the egress of the acute bisectrix, n_p, having a small $2v$. In sections approximately parallel to the pinacoid (010) there emerges a positive obtuse bisectrix. Besides the cleavage to (001) in these sections, a parting forming an angle of 77° to (001) is also observed. The extinction relative to the cracks of the basal plane is nearly parallel. The relief relative to Canada balsam is slight, but distinctly negative (with nepheline it is slightly positive). In a crack of feldspar, colorless radiated aggregates of an unknown mineral have developed, having a strong positive relief, a moderate double refraction (not above 0.012), a parallel extinction, and a negative character of the principal zone.

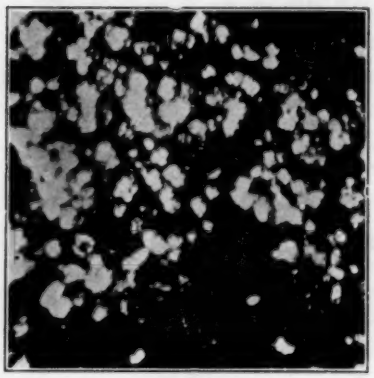

FIG. 2.—Nicols crossed. $^{50}/_{1}$.

In the second slide, as well as in the first, there are many bi-pyramidal prismatic crystals of rutile.

In the lumps of clay, there are mullite needles, rounded hexagonal leaflets with the refraction of corundum, also quartz.

This combination of nepheline, carnegieite, and orthoclase is characteristic. It indicates a lack of physical equilibrium, a difference in temperatures. Carnegieite is stable only at temperatures above 1248° and orthoclase cannot subsist at temperatures above 1200°.

The chemical analysis of the described crust was carried out by R. Bamm and gave the following results:

TABLE I

		Molecular quantities
SiO_2	45.55	0.759
TiO_2	0.77*	0.010
Al_2O_3	32.29	0.317
Fe_2O_3	1.92	0.012
CaO	1.12	0.020
Na_2O	11.07	0.178
K_2O	7.97	0.085
	100.69	

* TiO_2 was complementally determined by V. A. Egorov.

On account of incompleteness of both the microscopic and chemical analyses, a reckoning of the mineral constitution could be done only approximately:

		(%)
Nepheline and carnegieite	$Na_2O \cdot Al_2O_3 \cdot 2SiO_2$	50.55
	$K_2O \cdot Al_2O_3 \cdot 2SiO_2$	28.57
	$CaO \cdot Al_2O_3 \cdot 2SiO_2$	5.56
Mullite		4.73
Rutile		0.77
Residual Fe_2O_3		1.92
Residual SiO_2		8.57
		100.67

It is the weight percentage. With this method of reckoning, there is an excess of silicic acid. It is curious that this excess disappears if it is assumed that the K_2O indicates leucite (K_2O, Al_2O_3, $4SiO_2$) instead of the nepheline-carnegieite, 7.97%; K_2O corresponds with 37.06% of leucite; the remainder of SiO_2 is equal to 0.08%.

The latticed formations, however, refute the presence of leucite, and therefore these formations will continue to be called carnegieite conditionally, as the name of leucite would be a more conditional name.

From the chemical point of view the described crust from furnace No. 2 is characterized (1) by its relative poverty in SiO_2 in comparison with clay as well as with the batch from which glass is made, and (2) by a large content of alkalis. These latter have evidently been brought there by the batch dust that penetrated into the regenerator through the burners.

Our further investigations of new formations in regenerators showed that this phenomenon is not fortuitous, but constant in regenerating chambers.

Evidence from Another Furnace

In the chambers of another oval furnace, No. 8, the new formations on the checker brick were studied and the gas and air chambers were also investigated. In both, the blocks were covered with a thin crust of new formations, several millimeters thick. The crust on the brick of the gas chamber was crystalline, of a dark brown color, dry and porous; it could

be easily removed from the surface of the brick. The crust in the air chamber, on the contrary, was vitreous; it had the character of a dark, almost black glaze, which washed the brick and trickled down from it in small stalactite-shaped drops, 1 to 2 cm. long. They can be seen partially on the photograph of the brick (Fig. 3).

In order to have an approximate idea of the temperature that reigned in the furnace during the formation of the glaze, the experiment of softening the stalactite drops until a neck was formed between the base and the end of the stalactite was undertaken. These experiments were carried out in a tubular electric furnace where the stalactite was suspended on a platinum wire. The beginning of the formation of the neck was observed at 1125°. As most of the drops hanging down from the brick either had no neck or only a suspicion of it, it follows that 1125° is the approximate sought-for temperature of the formation of the glaze.

FIG. 3.—1/2.

The dry crystalline crust from the gas chamber was chemically analyzed by R. Bamm, the glaze from the air chamber of B. Shtcherbak (TiO_2 was complementally determined by V. A. Egerov). In Table II, the figures obtained by Bamm form column (1) and those obtained by Shtcherbak, column (3). The 2nd and 4th columns contain the molecular quantities of oxides.

The figures relative to silicic acid are still more striking. Here, it is not satisfactory (at least in the case of the crystalline formations) if it is

TABLE II

	(1)	(2)	(3)	(4)
SiO_2	45.02	0.750	58.55	0.976
TiO_2	30.02	0.290 (Al_2O_3)	1.72	0.021
Al_2O_3			21.90	0.215
Fe_2O_3	2.61	0.016	1.48	0.009
MnO	Traces		0.07	0.001
CaO	4.13	0.074	1.12	0.020
Na_2O	11.63	0.188	10.04	0.162
K_2O	6.82	0.073	5.71	0.061
	100.23		100.59	

admitted that they did not receive any SiO_2 from the batch, as a smaller quantity of this oxide was found in the new formations than in the fire brick considered separately.

The physical chemical significance of the indicated complexity seems to be that when the batch dust and the refractory blocks come into contact, they react with one another and without getting entirely mixed, form with their oxides such quantitative-chemical systems as require the least expense of work, namely, (1) the most fusible glasses, and (2) crystallic efflorescences and skeletons from such types of alkaline alumino-silicates as crystallize the most easily under the conditions.

A comparison of the analyses shows that although both crusts alike consist chiefly of alkaline alumino-silicates, still a great difference is observed in the relative acidity of the two compositions. While the crystalline product from the gas chamber is near in its chemistry to the fundamental nepheline-carnegieite crust from furnace No. 2, the glaze, on the contrary, contains a great excess of silicic acid that corresponds with the composition of the feldspar, rather than that of the nepheline.[7]

In both cases, a certain characteristic excess of $(Na_2, K_2, Ca)O$, is observed in comparison with the aluminate $(Na_2, K_2, Ca)O \cdot Al_2O_3$, present in normal alumino-silicates.

Applying Lövinson-Lessing's petrographic formulas, the following results are obtained for the crystallic crust, 1, 1RO, R_2O_3, 2.4 SiO_2, and for the glass, 1, 1RO, R_2O_3, 4.5 SiO_2.

The optics of the crystals of the first crust were not investigated by the authors because of the loss of the analyzed specimen. According to the chemistry of the specimen, however, there must not have been any essential difference from the above-mentioned crystals out of furnace No. 2 as well as from the crystals out of horse-shoe furnace No. 5, described below.

Regeneration Chamber of the Horse-Shoe Furnace No. 5

The new formations in the chambers of regenerators in this furnace were original. In both the gas and air chambers they had the aspect of efflorescences or crystalline skeletons, which fell to dust when merely pressed with the fingers. The thickness of these skeleton formations, deposited on the checker brick, sometimes reached 304 cm. It is obvious that in process of time, depositions of this nature must obstruct the gas ducts (parts) of the chambers, reduce the efficiency of the regenerators, and require a frequent replacement of brick.

The skeletons from the air chamber of the furnace had a pale yellow color, those from the gas chamber were of a dull gray.

The microscopic picture of both kinds of skeleton formations differed very little from the one observed by the authors in slide No. 1 from the crust of the regenerators No. 2. There were the same idiomorphic and more or less independent from one another crystallizations of nepheline

[7] Compare J. V. Wilson, "Notes on the Formation of Certain Rich Forming Minerals in and about Glass Furnaces," *Jour. Soc. Glass Tech.*, **2**, 197–213 (1918).

and carnegieite, and the same small pyramids and prisms of rutile. A peculiarity of the crystals of nepheline is an interrupted edging observed on their boundaries and formed of a mineral colorless like nepheline, but with a rather strong positive relief in the direction of nepheline as well as Canada balsam. Double refraction not above 0.012.

The chemical composition of the skeletons was determined by V. A. Egorov. The figures of column (1) in Table III relate to the skeletons from the gas chamber, the figures of column (3) to the skeletons from the air chamber of the regenerators. Columns (2) and (4) contain the molecular quantities of oxides. The figure of B_2O_3 in column (1) was found by M. Vichreva, B_2O_3, and As_2O_5 in column (3) by R. Bamm.

TABLE III

	(1)	(2)	(3)	(4)
SiO_2	43.10	0.717	42.79	0.713
TiO_2	1.20	0.015	1.18	0.015
Al_2O_3	27.28	0.268	26.25	0.258
Fe_2O_3	2.78	0.017	1.96	0.012
FeO	0.07	0.001	0.07	0.001
MnO	−0.17	0.002	0.06	0.001
MgO	0.61	0.015	0.43	0.011
CaO	2.36	0.042	1.45	0.026
Na_2O	8.75	0.141	8.48	0.134
K_2O	12.65	0.135	13.56	0.144
SO_3	0.06		0.73	
As_2O_5			0.69	
B_2O_3	0.68		1.80	
H_2O	0.42		0.26	
	100.13		99.71	

In accordance with the microscopic investigation, the chemical analyses of Table III give compositions which are similar to those of the crystalline formations from the oval furnaces No. 2 and No. 8. The only difference is a somewhat larger content of potassium in the skeletons from furnace No. 5. If the former carnegieite-nepheline explanation of the potassium is retained and Bowen's diagram[8] followed for the system $Na_2O{\cdot}Al_2O_3{\cdot}2SiO_2$, $K_2O{\cdot}Al_2O_3{\cdot}2SiO_2$, it must be admitted that the superfluous $K_2O{\cdot}Al_2O_3{\cdot}2SiO_2$ enters here mainly in the nepheline form of crystallization of an alkaline alumino-silicate.

The petrographic formula according to Lövinson-Lessing is the same for the skeletons from both chambers of the furnace No. 5:

$$(1)\quad 2\ RO\ R_2O_3\quad (2)\quad 6\ RO_2$$

Again, as in the case of the crystalline crust from furnace No. 8, there is a certain excess of RO as well as RO_2 in comparison with the norm for alumino-silicates of the nepheline type. RO is evidently found partially

[8] N. L. Bowen, *Amer. Jour. Sci.*, [4] **43**, 115–32 (1917).

in borosilicates, and in the skeletons from the air chamber with As_2O_5, too.

Conclusion

This is an exhaustive statement of all the facts and data gathered at the glass works, Drushnaya Gorka, and relating to the new formations in regenerating chambers. It is interesting to compare the composition of the formations with the composition of the fire brick and the glass batch.

The composition of the batch, especially its alkaline part, is not constant at Drushnaya Gorka. The composition of the glass manufactured at the works can give an approximate idea of the average composition of the batch, except its volatile components (CO_2, B_2O_3, As_2O_3, etc.).

Thus, in the following Table IV the chemical compositions of the following specimens are given:

(1) Glass typical for the works, Drushnaya Gorka.
(2) Fire clay (refractory blocks).
(3) Vitreous glaze from furnace No. 8.
(4) Crystalline new formations from furnace No. 2.

No. 5 and No. 8 (an average from the four analyses mentioned above).

TABLE IV

	(1)	(2)	(3)	(4)
SiO_2	73.18	56.91	55.55	44.11
$(Al, Fe)_2O_3$	1.84	38.95	23.38	31.28
CaO	8.20	2.54	1.12	2.24
$(Na, K)_2O$	16.78		16.75	20.23

In order to make it plainer only the most important oxides occurring in glass technique are used in Table IV.

This table also shows that the chemistry of the new formations is not at all a simple total of $m\%$ of fire clay and $(100-m)\%$ of batch dust, but that in reality other, much more complex, correlations take place here. For instance, while 100% of alkalis in the glass of the glaze, as well as in the crystalline crusts and skeletons come exclusively from the batch, the lime from this latter either does not enter at all into the new formations or forms quite insignificant quantities in them.

THE INTERPRETATION OF PLANT AND LABORATORY TEST DATA[1]

By Robert F. Ferguson[2]

ABSTRACT

Plant and laboratory test data may often yield more information if modern statistical methods are applied to them. Some of the more elementary concepts are defined and their method of application illustrated. The paper is intended to introduce the subject to those who have not yet studied it.

Introduction

Nearly everyone engaged in the ceramic industry must use test data to some extent. Whether one finds himself in the plant, the laboratory, or the executive office, he will have occasion to deal with collections of figures representing physical or chemical tests of some sort. These data may be any property that can be measured and expressed numerically. Irrespective of who has prepared them, their practical value depends, to a large extent, on the manner in which they are interpreted. It is sometimes possible for different readers to draw opposite conclusions from the same set of test data. Fortunately, there are mathematical methods which will eliminate, largely, this personal factor from the interpretation and which will enable the real significance to be determined. These methods are generally called statistical methods and have been extensively applied in such diverse fields as sociology, business administration, and biology. This very fact has hampered somewhat the application of statistical methods to ceramics, since most of the books on the subject have been written by specialists in other branches.

But the use of statistics in ceramic research is growing rapidly,[3] and the time has now come when some knowledge of statistical theory is necessary to ceramic workers. Many problems can be solved in shorter time than by the older methods, and data that are compiled can be made to yield more information by their use. Statistical methods find their most useful application where there are many factors beyond the control of the investigator, a situation frequently encountered in ceramic investigations.

The subject is far too large to be covered in one paper. This article must, therefore, be limited to defining a few of the more important concepts and to illustrating their application, for the purpose of introducing the subject to those who have not yet studied it. The methods that will be developed are applicable to nearly any property of any material and are

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[1] An address given before the Pittsburgh Section of the American Ceramic Society, January 11, 1930. Received March 31, 1930.

[2] Industrial Fellow, Mellon Institute of Industrial Research.

[3] The use of statistical methods was called to the attention of ceramists by A. E. R. Westman, *Jour. Amer. Ceram. Soc.*, **10**, 134 (1927).

not limited to the examples given. It will be necessary for the reader to find for himself cases where these methods can be applied to his own work. A concrete example will serve the purpose most quickly. Table I shows the modulus of rupture of fifteen fire brick as determined in the

TABLE I

Sample	Modulus	Deviation	$(\bar{x} - X)^2$
1	558	191	36,481
2	568	181	32,761
3	600	149	22,201
4	652	97	9409
5	668	81	6561
6	703	46	2116
7	728	21	441
8	747	2	4
9	762	13	169
10	779	30	900
11	817	68	4624
12	873	124	15,376
13	892	143	20,449
14	910	161	25,921
15	974	225	50,625

Mean	749	Effective average	622
Median	747	Standard error of mean	33
Probable error	84	Standard error of standard deviation	23
Standard deviation	127		

usual manner, except that the results have been arranged in order of magnitude. It is assumed that these fifteen samples have been taken at random from a much larger group and are representative of that group. It is further assumed that the testing has been carefully done by an accepted method.

Averages

It is desired to obtain from these figures a value that will characterize the entire series. For this purpose, nothing can surpass the arithmetical mean with which the reader is already familiar. The mean is obtained by adding all the items and dividing the sum by the number of items. This is expressed by the formula:

$$\bar{X} = \frac{\Sigma X}{N}$$

Where $\bar{X}$ is the mean
Σ is the summation sign
X is the individual item
N is the number of items

From the data in Table I, the mean is found to be 749.

There are, besides the mean, other averages that are useful in special cases. Unless there is some good reason for using them, however, the mean is the value that should be employed. The median, an average that is occasionally useful, is defined as the value of the middle item when

the results are arranged in rank. In the example, the median is the value of the eighth item or 747. It will be seen that the median will not be affected by extremely high or extremely low results and for this reason it is valuable where such results are likely to be encountered. The water-dip spalling test is a good example of the use of the median. An occasional brick will be found that will survive the test long after its mates have failed. This extreme result will affect the mean, although it is obvious that it cannot affect the value of the brick in service. One brick remaining in a wall after the surrounding brick have failed can be of no benefit to the masonry. In this case, then, the median would better characterize the sample than the mean.

Measures of Dispersion

Although the mean is the best average with which to characterize this particular lot of fifteen samples, it will be seen, on examining the table, that there is a great deal of information included in the data which the average does not reveal. The average gives one figure around which the determined values fluctuate, but tells nothing of the extent or nature of the fluctuation. Besides knowing the mean, it is important to know something of the degree of dispersion of the individual items if the results are to be properly interpreted.

Distribution Curves The degree of dispersion can be shown graphically by means of a distribution curve. If the results are plotted so that the abscissa represent values and the ordinates represent the frequencies with which these values occur, a graph will be obtained which is called the distribution curve. It has been found that in many natural phenomena, the distribution is arranged as shown in Fig. 1. The curve shows that most of the measurements are clustered closely around the center value and those measurements that differ greatly from this value are found in much fewer numbers. This distribution has been found to be so nearly universal in the natural world that it is called the normal distribution. In view of what has been discovered in other sciences, and in the absence of research to the contrary, we may assume that the properties of ceramic bodies approximate a normal distribution, and we can apply to ceramics the laws which have already been developed.

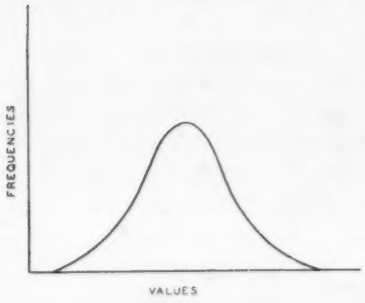

FIG. 1.

Average Deviation Referring again to Table I, we find that the values run from 558 to 974. This range could be given

to indicate the extent to which the results are dispersed, but such a report would be of no value because it would give only the extremes and would place the emphasis on the least important results. Another possible method would be to determine the average deviation of the individual results from the mean. This would be done by adding the figures in the second column of Table I (neglecting signs) and dividing by 15, expressed by formula:

$$\text{A. D.} = \frac{\Sigma(\bar{X} - X)}{N}$$

The average deviation is a useful measure of the consistency of the data, and is quite satisfactory for many practical problems. When the data are to be given more elaborate treatment, the standard deviation, to be described later, is preferable because it is more amenable to mathematical treatment.

Probable Error Still another measure of dispersion is the probable error, as it is called in physical sciences, or the quartile deviation as it is called in economics. This is the range that will include one-half of the results. In the example in the table, the probable error is 84. We could, therefore, report the average modulus as 749 with a probable error of ± 84, which would mean that of all the determinations which we might make on this lot of brick, one-half of the results would fall between these limits.

The probable error has little to recommend it except that it is widely used. It is frequently mentioned in the literature simply because its use was established before the more modern concepts were discovered. The probable error has now been largely superseded by the standard deviation, which is more suitable for mathematical manipulation and which will be defined later. In symmetrical distributions the probable error is 0.67449 times the standard deviation and it is customary to consider two-thirds the standard deviation as the probable error.

$$\text{P. E.} = 0.67449\sigma$$

Standard Deviation It will be seen on the distribution curve that there is a point on each side where the curve changes from concave to convex and the distance between these points of maximum inflection furnishes us with our most useful measure of dispersion. This range will include all the closely-grouped values lying under the dome of the bell and will exclude the scattered extreme values that go trailing off into the tails of the curve. This measure is called the standard deviation and is represented by the Greek letter "sigma." It is calculated as follows: the deviations from the mean (column 2, Table I) are squared and averaged and the square root extracted.

$$\sigma = \sqrt{\frac{\Sigma(\bar{X} - X)^2}{N}}$$

The standard deviation is of great importance, as will be seen later, and it furnishes us the key to the correct interpretation of our test results. If the arithmetical mean, the number of samples, and the standard deviation are reported, there is hardly anything more that can be said about a series of tests. If these three values are given in publishing test results, the individual results can be omitted frequently with a saving of journal space and the reader's time.

The merits of the standard deviation consist in the fact that its significance is the same for all normal distributions. Only one result in three will have a deviation greater than sigma. That is, the mean plus or minus the standard deviation will include two-thirds of all the possible values. Deviations greater than twice sigma will occur once in every twenty-two times. Deviations greater than three times sigma will occur once in every three hundred and seventy times, and six times sigma will be exceeded only once in one billion times.

The reader must be cautioned that the standard deviation as determined from a small sample will not be the true standard deviation, but will, itself, be subject to an error equal to $\frac{\sigma}{\sqrt{2N}}$. It is beyond the scope of this paper to discuss the small sample theory and the reader is referred to more comprehensive discussions of the subject.[4] For the sake of simplicity, the examples that follow will be treated as they would be if the true value of sigma were known. In actual practice, it would be necessary to divide sigma by a correction factor depending on the number of samples before the true significance of the results could be determined.

Some of the uses that can be made of the standard deviation will now be illustrated. In the first place, it furnishes an indication of the reliability of the test and the precision to be ascribed to the individual results. For example, in our laboratory we have determined the standard deviation on several brands of fire brick when submitted to the hot load test. For one type of brick having a good load-carrying capacity, the standard deviation in the test as we made it was 0.5%. In future work with brick of this type we shall consider that results within 0.5% of each other are checks, that there is nothing gained by making a distinction, let us say, between a brick showing 1.0% deformation and one showing 1.2%. On the other hand, for brick of a different type having a rather high deformation and considerable variation among samples, the standard deviation was 1.7%. In the light of these figures it would not be fair to say that

[4] W. E. Shewhart, "Correction of Data for Errors of Averages," *Bell System Tech. Jour.*, **5**, 308–19 (1926).

brick "A" is better than brick "B" if "A" deformed 8% and "B," 9.5%, because in this test the results will vary over this range even when the samples are drawn from the same lot.

The same reasoning can be applied in comparing two or more testing methods. Working with identical samples, the method that gives the lowest deviation is the more consistent test.

Effective Average

Conversely, when the same testing method is used, the product that shows the lowest standard deviation would be considered the most uniform, and would, therefore, possibly be the most desirable. This method of evaluating results was proposed a number of years ago by our fellow member, Donald W. Ross.[5] Mr. Ross proposed to judge the cross-breaking strength of fire brick by subtracting the standard deviation from the mean. He named this result the effective modulus. This is shown in the following formula:

$$\text{Effective average} = \bar{X} - \sigma$$

The logic of this scheme can be readily appreciated. A brand of brick that varies within itself a great deal will be penalized, while a uniform brand will benefit. The mathematical significance of this effective average will be recognized. If the standard deviation is exceeded once in three times, and if there are as many positive as negative results, the negative value of sigma will be exceeded once in six times. In other words, only one brick of every six will have a modulus lower than the effective modulus. The mean gives the load that approximately one-half of the brick can withstand without breaking, but the effective modulus gives the load that five-sixths of the brick can withstand. This effective average is a valuable concept that could well be applied in many cases. It might be used with benefit in specifications. If the five-sixths strength did not furnish sufficient margin of safety, an effective average could be specified which would be the mean minus twice the standard deviation. This would give the figure at which only one specimen out of forty-four would fail. Specifications written in this way would be more valuable to the consumer and fairer to the producer than by simply specifying an average value. This is true especially in cases where the product is not uniform and where scattered failures are not disastrous, as, for example, in paving brick.

Another question frequently arises concerning gross errors. In a series of tests, an occasional result is obtained which is considerably removed from the average. It is often ascribed to a defect in the sample, or to some gross error in manipulation or recording. The investigator is often tempted to throw out these ugly ducklings. On the other hand, if they do belong, he is only too anxious to include them. When the standard deviation is calculated, there is no need to guess about the matter, because

[5] D. W. Ross, Bur. Stand., *Tech. Paper*, No. 116, p. 80 (1919).

it is known how many times deviations greater than twice sigma will occur by chance.

Errors

Another question that deserves more attention than it sometimes receives in both research and testing, is the size of sample that is necessary. It is desirable to use as small a sample as possible to save time, money, and unnecessary labor. It is, however, absolutely necessary to have a sufficiently large sample to obtain significant results from which definite conclusions may be drawn. If the samples are too small, the results will have little value and may be actually misleading. It is obvious that the size of the sample necessary will depend on the precision of the testing methods and on the degree of uniformity. Both these factors influence the standard deviation. The size of sample necessary, therefore, can be judged from the standard error of the mean. This is given by the formula:

$$\text{Standard Error of Mean} = \frac{\sigma}{\sqrt{N}}$$

If this error of the mean is too great it indicates that a larger sample is needed. The method used by Parmelee and Westman[6] was to set a figure as the permissible error of the mean. If this was not exceeded in the first set of tests, the results were accepted and used. But if $\frac{\sigma}{\sqrt{N}}$ exceeded the permissible figure, more samples were taken and a new average obtained. In this way, all the brands tested were on an equal footing and all the means had the same degree of precision. It will be seen that the error of the mean can be reduced more quickly by reducing sigma than by increasing N, so that it is better to control the variables in the test than to resort to larger samples. This method could be used in determining the number of samples to be taken when drawing up standard testing methods. The error of the mean also furnishes a valuable criterion in comparing results from various laboratories.[7]

Referring to the table, we find that the standard error of the mean is 33. If we are not concerned with differences of less than 50 pounds, the sample is large enough. If we are trying to make distinctions as fine as 20 pounds, we shall need a larger sample and there is no use trying to make such fine distinctions with the results before us. If we were to take 15 more of the same brick next month and determine the modulus, we would expect the average[8] to lie between 720 and 780. If it does, we can consider that the product has not changed. But if the average falls be-

[6] Univ. Ill., Eng. Exp. Sta., *Bull.* No. 179 (1928).

[7] W. A. Shewart, *Proc. A.S.T.M.*, **29**, 200 (1929).

[8] The error of the mean has the same significance as the standard deviation; *i.e.*, one result out of three will exceed this figure.

low 720 or above 780, we shall be justified in concluding that there has been a change in the product.

Comparison of Two Means

Another formula that we have found useful and easy to apply concerns the difference between two means. It is frequently desired to compare two products in respect to some physical property. In fact, a great deal of testing has this view and is more concerned with the difference found than with the actual values. You will, of course, run two sets of tests and average the results. But it remains to be decided whether the difference between these averages is significant or whether it can be ascribed to chance variations in the sample. The answer is given by the standard error of the difference between two means. The formula is as follows:

$$\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}$$

This gives the difference that is likely to occur between two means when the samples are drawn from the same lot. If the actual difference found between the means in the test exceeds this standard error by three times, it represents a chance occurrence of once in three hundred and seventy times and is considered significant. If the actual difference is only twice the standard error, the results are of doubtful significance.

To take a concrete example, let us assume that the brick represented in Table I have been modified in some way. Perhaps clay from a new source has been substituted for one of the constituents or the firing schedule has been changed. It is desired to know, what, if any, has been the change in the modulus caused by the new method. A sample is selected, the modulus is determined, and an array of figures is obtained as in Table II. Looking at the results, it appears that the brick in Table II run a

TABLE II

Sample	Modulus	Sample	Modulus	Sample	Modulus
1	617	6	774	11	849
2	662	7	785	12	855
3	675	8	791	13	866
4	696	9	799	14	873
5	735	10	845	15	1013
	Mean				789
	Standard deviation				102

little higher than in Table I, but there are many results in Table II below the average for Table I, and the difference between the averages is considerably less than the brick-to-brick variation of each lot. May we say that the higher average of Table II indicates a stronger brick, or is this a chance variation due to the inherent lack of uniformity of the samples? It is probable that if this question were left to individual judgment, there

would be a diversity of opinions. But, when we apply the formula, we find that the standard error of the difference between the two means is 42. The actual difference is 40, or less than the probable difference; hence there is no justification in distinguishing between the samples.

The above process has been used in our laboratory with considerable advantage. Recently, it was desired to compare two lots of brick with respect to resistance to spalling. In all, seventy-two brick were used and were given a definite spalling treatment. Samples of each lot were selected at four different times. To complicate matters further, our furnace would not hold all of the brick, so that it was necessary to make three different runs. A beautiful maze of figures was obtained which, on examination, showed that the brick had lost weight in the test, but which showed very little in addition to this fact. Without some mathematical treatment, the report would have been almost worthless, although the cost of the test was several hundred dollars. A little statistical treatment, however, showed a great deal. All of lot "A" and lot "B" were averaged. The difference between these means was found to be three times the probable difference. This was taken to be significant. When the results of the three furnace runs were compared, the difference was found to be less than the probable error. The same thing was done with the samples taken at different times. It was, therefore, concluded that there was no significant difference among the brick as made from day to day at the same plant, that our testing method was sufficiently accurate to make repeated runs comparable, and that the difference found must be ascribed to an inherent superiority of lot "A" over lot "B."

Conclusions

The reader must be reminded that this paper merely touches on the subject and if further study is desired, reference may be had to an Intro duction to the Mathematics of Statistics, by R. W. Burgess (Houghton, Mifflin Company) or "Application of Statistical Methods in Physiology," by Halbert L. Dunn,[9] each of which contains an extensive bibliography. There is undoubtedly a certain field of usefulness for statistical methods in ceramic research and testing, if properly applied. When fully understood, they will prove a new tool in solving some of our problems.

[9] *Physiological Rev.*, 9 [2], 275–398 (1929), School of Hygiene and Public Health, Johns Hopkins University, Collected Papers, Vol. 10, No. 54.

AN IMPROVED MERCURY VOLUMETER[1]

By J. F. McMahon[2]

ABSTRACT

This paper discusses several mechanical improvements on the Goodner mercury volumeter, which include a counter-balance for the burette, an automatic light system, and a plunging device. The construction, operation, and advantages of the plunging device are discussed. The advantages of the mechanism are (1) no string or string marks, (2) cleaner mercury, (3) no bulky weight to be deftly handled, (4) less handling of briquets, and (5) more ease and speed in operation.

Introduction

The Goodner volumeter[3] has found its way into quite a number of ceramic laboratories and has, by its accuracy and simplicity, added materially to the ease and speed of clay testing.

The present paper has to do with the construction of the volumeter with special reference to (1) a counter-balance for the burette, (2) a light signal for obtaining mercury levels, (3) a safe connection between the rubber hose and mercury reservoir, and (4) a means for lowering and raising the briquets into and from the mercury.

Figure 1 shows the assembly of the improved volumeter together with sketches of the additions.

Manipulation

The backboard of the apparatus being screwed firmly to a wall, the burette being so located that the zero mark of the burette is even with the platinum tip of the rod, *I*, and mercury (the carriage submerged therein) being at the zero level, the apparatus is ready to use.

By pulling up on rod, *F*, the cage, *G*, is withdrawn from the mercury. When the cage, *G*, is free of the reservoir, its front opens outward and downward, permitting the insertion of the briquet. The briquet being inserted in *G*, the rod, *F*, is pushed downward (automatically closing the basket of the holder) until the basket and briquet are completely submerged in the mercury and the steel block which is just above the holder is partially submerged. By bringing the carriage, *B*, downward, the mercury level is once again brought to its previous level (at the platinum tip of the rod, *I*). While the mercury level is too high the bulb, *H*, is lighted, and

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[1] Published with the permission of the Director, Mines Branch, Department of Mines, Ottawa, Canada.

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[2] Ceramic Engineer, Mines Branch, Department of Mines, Ottawa.

[3] Ernest F. Goodner, "A Mercury Volumeter," *Jour. Amer. Ceram. Soc.*, **4**, 288 (1921).

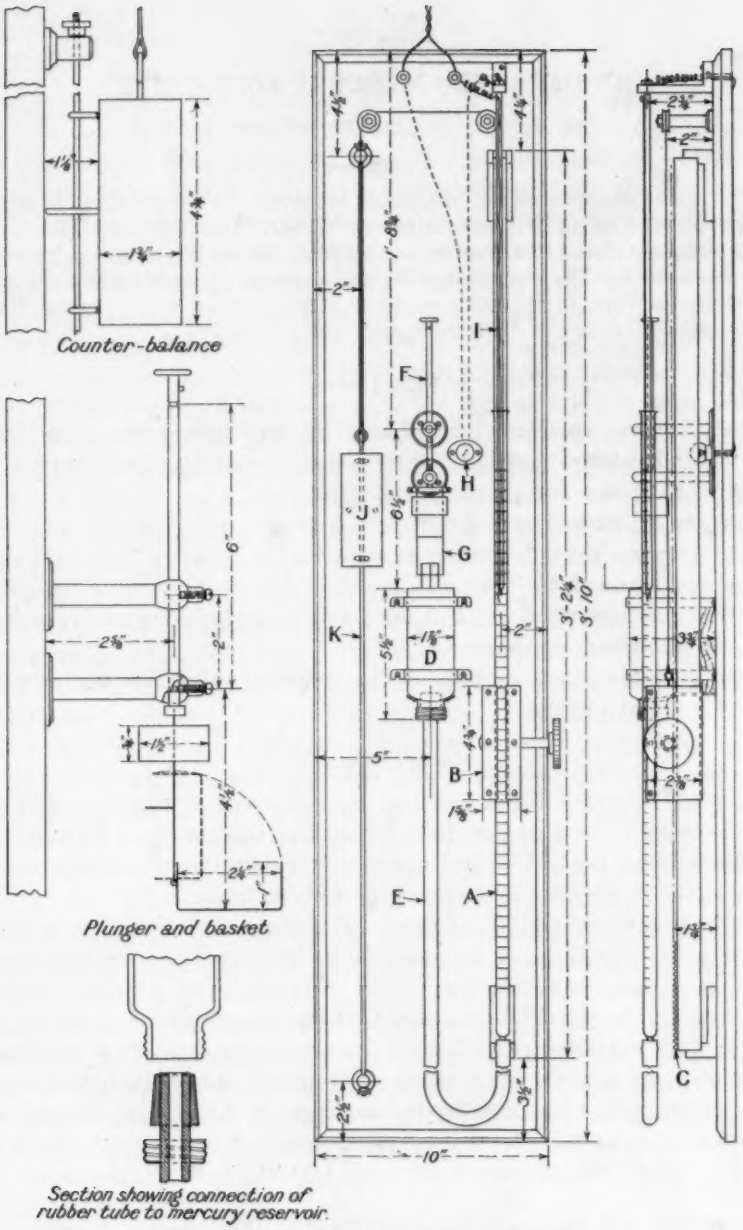

FIG. 1.—Improved Goodner mercury volumeter.

Reference

A—Burette
B—Burette carriage
C—Geared rack for burette carriage
D—Mercury reservoir
E—Rubber tube
F—Plunger
G—Wire basket
H—Light
I—Rod projecting into burette
J—Counter-balance
K—Guide rod for counter-balance

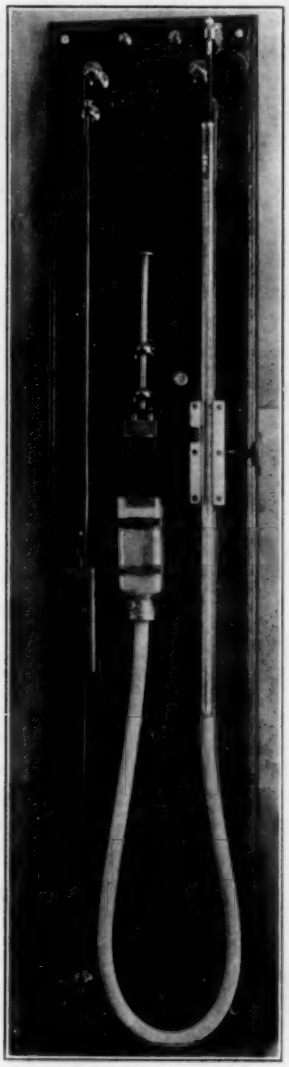

FIG. 2.—Improved Goodner mercury volumeter.

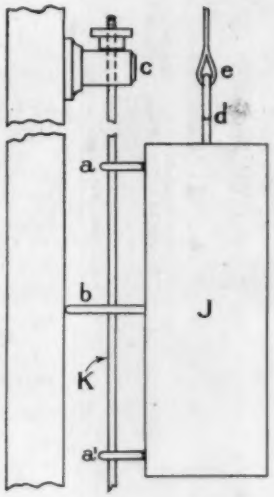

FIG. 3.—Counter-balance.

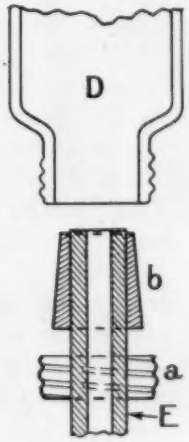

FIG. 4.—Section showing connection of rubber tube to mercury reservoir.

when too low the light is out; a proper reading point is obtained just as the light goes on or off. The burette is then read, giving directly the volume of the briquet.

In Fig. 3 (side elevation), the counter-balance, *J*, is a brass box provided with an open top which permits the insertion of lead shot or other

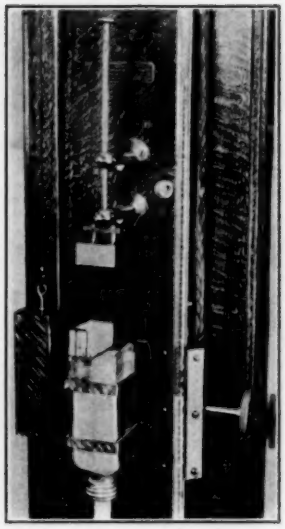

FIG. 5.—Briquet in position.

weight for obtaining a balance. The vertical rod, *K*, acts as the main guide for box, *J*, while eyelets, *a* and *a'*, which run over *K* prevent the box from swinging outward or to one side and legs, *b*, prevent the box from rotating.

The rod, *K*, is connected, top and bottom, to the backboard as is shown at *c*. To the hook, *d*, is fastened a gut clock cord, *e*, which passes over two pulleys (see Fig. 1) and is attached to the burette carriage, *B*, on the opposite side of the apparatus.

The advantage of the counter-balance is obvious, affording easy movement of the carriage and assuring its remaining in any set position.

Figure 4 shows a section of the connection of the rubber tube to the mercury reservoir. The pressure tube, *E*, passes through a hole in the bottle cap, *a*, and through a hole in the rubber stopper, *b*, into which it is well cemented. The rubber stopper is pushed into the mouth of the bottle, *D*, until tight. The cap, *a*, is then screwed into position on the bottle.

This connection is easily detached when it is necessary to clean the mercury.[4] All danger of pulling out is eliminated.

Figure 6 shows a side elevation of the means by which the briquets are lowered into and raised from the mercury. The two brass brackets, *a* and

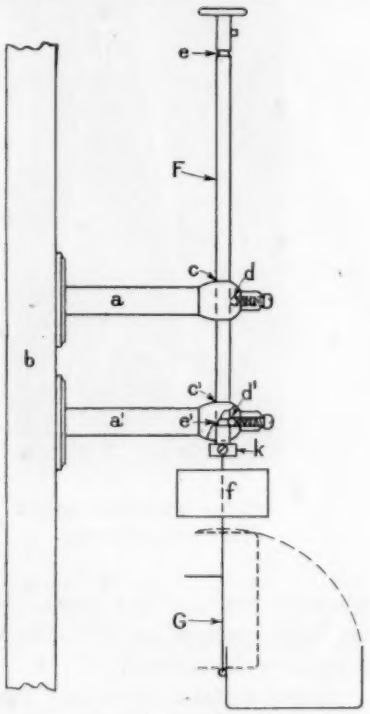

FIG. 6.—Plunger and basket.

[4] A handy way of cleaning the mercury is given in Gas Analysis by L. M. Dennis, p. 118. The mercury passes by gravity from a mounted vessel through a drawn tube (which produces a very fine stream), falls into water (which forms globules of mercury) and falls to the bottom of the vertical water tube (which is 1 meter long and 2 or 3 cm. in diameter) from which it is automatically syphoned off, cleaned. The process is continuous and requires no attention after the mercury is placed in the vessel.

a', are screwed firmly to the backboard, b. These brackets are provided with holes at c and c', through which the plunging rod, F, passes. The brackets are also provided with ball and spring latches, d and d'. The plunging rod, F, is grooved at two points, e and e', which engage respectively with d and d'.

These grooves set the upper and lower moving limits of the rod. When rod, F, is moved upward until the groove, e', is opposite the ball of d', the ball being under pressure is forced into the groove and the rod brought to a stop. This is the position shown in the sketch, at which position the basket is entirely free of the reservoir. When the rod, F, is lowered until the groove, e, is opposite d, a similar connection is made and this sets the lower limit of the rod. At this position the cage, G, is completely covered by mercury and the steel block, f, is partially submerged.

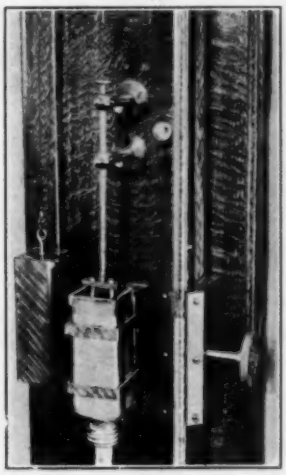

FIG. 7.—Set for a reading.

The steel block, f, serves to restrict the surface area of the mercury in the reservoir to approximately the area of the mercury in the burette, thus insuring sensitivity.

The wire cage, G, and block, f, are attached to the plunging rod by the frame wire, the two ends of which extend up to a brass plate, k, where they are connected by set screens. The brass plate, k, screws onto the plunging rod, F.

A briquet being in position, the plunging rod is lowered slowly, the basket of the cage coming into contact with the side of the reservoir is closed forming a complete cage for the briquet while under the mercury. The cage is made of 16-gage iron wire, all joints (3) spot welded.

The advantages claimed for this plunging device are (1) more speedy operation, (2) elimination of string marks on briquets, (3) cleaner mercury, and (4) centering of briquets in mercury.

Figure 1 shows the complete set-up from which the light system can easily be traced. It is similar to the set-up for the use of a bell.

The steel rod, I, provided with a platinum tip (brazed and shellaced) forms the electrode which regulates the setting-up of the instrument. An insulated, platinum-tipped wire, paralleling the steel rod but extending downward one-half inch farther, serves as the other electrode.

The eye is so placed when reading the mercury levels that when contact is made, the reflection of the light on the mercury acts as the necessary signal.

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Abrasives

Face grinding. ALAN A. WOOD. *Abrasive Ind.*, **11** [3], 16–20 (1930).—How much stock can be removed by grinding? For an average run of medium sized work in gray iron with medium contact surfaces, $^1/_8$ in. has been frequently taken as a good average stock removal from the face of the work. This does not mean that $^1/_8$ in. is taken in a single pass of the wheel, but there will be as many passes as the ratio $\frac{^1/_8}{d}$, where d is the average depth of cut. This rule is subject to modifications and exceptions. Some of the factors controlling the individual depth of cut are (1) kind of material, (2) finish required, (3) contact area between wheel and work, (4) distribution of stock in contact with wheel, (5) accuracy required, (6) competition with other kinds of machining, *i.e.*, hardness and brittleness, (7) desire to preserve edges, (8) heating, etc. The function of

a machine tool should be to create a finished surface rather than to manufacture chips. Use should be made of both silicate and vitrified bonds. Frequently silicate bonds are more successful in grinding steel, as shear blades or locomotive guide bars, and vitrified bonds find better application in the grinding of cast iron, bronze, etc. Clean, sharp wheels usually leave a rougher finish on the work than wheels which are slightly smoothed or even slightly loaded. In face grinding it is possible with a cylinder or face wheel, to leave the finish as rough as that usually obtained with milling cutters run at highest speed, and it is also possible to obtain surfaces (sometimes with the same wheel) which have almost the refractive property of glass. Some plate glass is polished by a process closely resembling face grinding. In attempting to polish metal by face grinding, it should be remembered that practically all polishing operations consist in reducing scratches to minute size and in rearranging the scratches to the best advantage. Face grinding is a combination of true abrasion, burnishing, and the shearing action of the edge of the wheel. The relative importance of each component depends on the particular job. The scratches formed by the path of the grinding particles in face grinding are the result of a circle rolling on a straight line, *i.e.*, almost a theoretically correct cycloid. The face grinding machine is most frequently used as a production machine. The maximum size of grain which is generally used in the segment wheels employed is hardly ever No. 14 which implies that no grain greater than $^1/_{14}$ in. can pass through the mesh of that particular screen. E.P.R.

Automatic sizing features gear grinding practice. B. K. PRICE. *Abrasive Ind.*, **11** [3], 27–28 (1930).—At the plant of the International Motor Co., New Brunswick, N. J., 3-speed nickel steel gears are ground to limits of 0.0005 in., and on a typical size, where the hole is $1^5/_8$ in. at the rate of approximately 20 an hour with an alumina wheel $1^1/_2$ by $1^1/_4$ by $^3/_8$ in., 60 grit, M. grade. Throughout the roughing operation, the wheel is held constant at a surface speed of 5000 ft. per min., while the work is rotated at 290 r.p.m. The roughing feed on this size of work is maintained at about 30 ft. Following a series of roughing cuts which leaves, 0.00125 in. to be ground, the wheel is automatically withdrawn and trued by a diamond at a reduced rate of feed. This feed is operated at a reduced rate during the finishing processes. These operations, including the sizing, are all automatic. E.P.R.

Carboloy as a cutting tool. S. L. HOYT. *Can. Chem. Met.*, **14** [2], 54 (1930).—Tungsten carbide and cobalt metal powder are mixed in a ball mill, pressed in steel molds into soft bars which are heated at a low temperature. In this shape they are worked and converted roughly into their final form. The combination is heated to 1400°C for $1^1/_2$ hours, and this treatment cements the tungsten carbide with the cobalt. In general, cemented tungsten carbide is speeding up machining operations, in particular cases increasing production, as compared with tool steel, from 20 to 50 times. See also *Ceram. Abs.*, **8** [3], 209 (1929). E.J.V.

Proper care conserves industrial diamonds. ANON. *Abrasive Ind.*, **11** [3], 29–30 (1930).—Industrial diamonds are called bort. South African diamonds are known as Cape bort while those from Brazil are Brazilian bort. There are also carbon or carbonado stones found in Brazil. These sometimes are called black diamonds. Cape diamonds are in more general use than other varieties for grinding wheel dressing. Brazilian diamonds are comparatively hard and also high in price. Carbons are used for rock drilling and for special turning, boring, or shaping tools. The diamond has an octahedral fracture and is composed of a number of octahedron crystals. The large majority of diamonds have minute flaws and gas pockets. The gas is held under tremendous pressure and very often further pressure when the diamond is heated will cause it to burst. A diamond is very weak parallel to its cleavage planes or grain, and will not cut in that position. It cuts keenly and is strong at right angles to the

grain. A diamond will resist tremendous steady pressure, but under blows or shocks, it splits easily. Overheating a diamond injures its temper and makes it lifeless and brittle. It is also liable to crack if subjected to sudden cooling. When a diamond is set, it must be securely held with the metal touching it completely round the buried surface or the slightest movement of the diamond in its setting will break it. Brown diamonds are softer than grays, whites, or blacks, but they will stand more abuse without breaking. The ballas diamond is the hardest and toughest because it has an internal radiated grain. E.P.R.

Predict scarcity of diamonds for industrial uses. ANON. *Abrasive Ind.*, **11** [3], 26 (1930).—The "Big Four" (the diamond mines), in agreement with the Diamond Syndicate, will not ship any diamonds for three months. The London Diamond syndicate has sold practically its entire stock of industrial diamonds, so that a scarcity is to be expected this year. Ballas diamonds were very much in demand for they do 10 to 100 times the work of other diamonds. Also Jägersfontein diamonds and brown borts are much in demand. The use of shaped tools is on the increase, as by proper application 30,000 objects can be turned with a diamond as against 50 with steel. E.P.R.

Surface grinders. ANON. *Abrasive Ind.*, **11** [3], 35 (1930).—Reid Bros., Inc., Beverly, Mass., recently was formed to manufacture surface grinding machines. E.P.R.

Grinder finishes large parts. ANON. *Abrasive Ind.*, **11** [3], 41 (1930).—The machine described is a plain, self-contained cylindrical grinder having a swing 28 in. over the work table and 40 in. in the gap, with a length capacity of 48 in. between centers. This grinder was constructed by the Cincinnati Grinders, Inc. E.P.R.

Suggestions for grinding metal-cutting tools. ANON. *Abrasive Ind.*, **11** [3], 22–23 (1930).—A few points of importance in grinding tools for cast iron are given with several examples to illustrate graphically the fundamental features. The important factors to be observed are (1) arc of contact, (2) position of tool above or below center, (3) angle of face clearance, (4) heel clearance, (5) angle of back clearance, and (6) support of tool. E.P.R.

Grinding rolls in sheet and tinplate mills. ANON. *Iron and Steel Ind.*, **2**, 322 (1929).—A short account is given of a portable grinding machine for grinding rolls of sheet and tinplate mills while in the housings. (*J.I.S.I.*)

Uneven heating causes grinding wheel breakages. REVERE CHAPELL. *Abrasive Ind.*, **11** [3], 24–25 (1930).—If the temperature of the wheel remains constant and uniform throughout its entire structure it should not break. Heat is generated in the grinding operation to such an extent that actual fusing of the metal chips takes place. If no coolant is used, some of this heat is transmitted to the wheel face. When coolant is used, as in precision grinding, little heat is transmitted to the wheel from the chip. In dry grinding it is also negligible unless the sparking is uninterrupted. The most important source of heat to be considered in either wet- or dry-grinding operations is pressure of the wheel against the work and the friction heat generated by the non-cutting resistance of dull surface grains on the working face of the wheel. Two grinding operations are cited to illustrate these two different sources of heat. E.P.R.

Finishing pistons. ANON. *Abrasive Ind.*, **11** [3], 31–32 (1930).—This article illustrates and describes some grinding operations performed at the Aluminum Industries, Inc., Cincinnati, which ranks among the heaviest producers of aluminum alloy pistons in the U.S. E.P.R.

Grind flask pins accurately. ANON. *Abrasive Ind.*, **11** [3], 28 (1930).—The units illustrated are pins and bushings fitted in lugs located on the ends of the cope and drag members of an ordinary foundry flask. The parts are of low carbon steel, case

hardened, and finished by precision grinding. A satisfactory degree of accuracy is assured, and it has been found cheaper to grind the pins and bushings than to finish them by other means. After grinding, the parts are forced in the cope and drag lugs and the result is that the two sections can be located with a high degree of accuracy and the pins are not bent or broken as readily as were the types formerly used. E.P.R.

Vertical honing machine. ANON. *Abrasive Ind.*, **11** [3], 41–42 (1930).—For greater accuracy and smoother finishing of Diesel engine and similar cylinders, the Barnes Drill Co., Rockford, Ill., developed a vertical honing machine which has a 36-in. swing and hones cylinders up to 20 in. in diam. and 54 in. long. Illustrated. E.P.R.

Polishing machine has two belts. ANON. *Abrasive Ind.*, **11** [3], 40–41 (1930).—The machine is a double-belt polisher developed by the Defiance Machine Works, Defiance, Ohio, for polishing inner portions of circular work and irregular-shaped parts. The frame of this machine is designed so that it occupies a minimum amount of floor space and the polishing belts are arranged so that two operators can work on the machine at the same time. Illustrated. E.P.R.

Polishing information for hard rubber and pyralin. ANDREW V. RE. *Abrasive Ind.*, **11** [3], 37 (1930).—The buffing of corners can be done with a regular sewed buff. Color buffing while articles are warm is faster and gives a better luster. The tripoli used for cutting down leaves a film on the work which is hard to remove when cold. E.P.R.

New polishing material. ANON. *Pit and Quarry*, **19** [7], 87 (1930).—The Bunton Green Stone Co. of West Chester, Pa., has developed a material called vermiculite, which is claimed as a universal polisher; it will smooth and polish glass or the hardest metal. E.P.R.

Acquire wheel company. ANON. *Abrasive Ind.*, **11** [3], 32 (1930).—The Allied Industrial Products Co., Chicago, recently acquired the Advance Wheel Mfg. Co., manufacturer of polishing wheels. They purchased the Peters Buff Co. and the Chicago Wheel & Mfg. Co. E.P.R.

Ancient grinding appliances. ANON. *Abrasive Ind.*, **11** [3], 38 (1930).—A power plant wherein a waterwheel drives a grindstone, a grain mill, and a stamp mill is described and illustrated. E.P.R.

German abrasive industry. ANON. *Mining Jour.*, **168** [4928], 82 (1930). E.C.C.

PATENTS

Tool grinder. WILLIAM EMERY LUTZ. U. S. 1,749,105, March 4, 1930. In a tool-grinding apparatus for application to and actuation by a motor including the usual motor shaft having a polygonal socket and a housing for the shaft, the shaft having polygonal portions and an intermediate cylindrical portion, one of the polygonal portions being adapted to be fitted into the socket in the motor shaft, and abrading member longitudinally adjustably mounted upon the other polygonal portion of the shaft, a head rotatably mounted upon the cylindrical portion of the shaft and having an internal gear portion at its periphery, a pinion fixed upon the cylindrical portion of the shaft, a sleeve loosely surrounding the cylindrical portion of the shaft, a bracket extending from the sleeve, a pinion rotatably mounted upon the bracket and meshing with the internal gear and with the first-mentioned pinion, means for holding the sleeve stationary with respect to the housing for the motor shaft and means upon the head for supporting a tool in contact with the abrading member.

Grinding machine, etc. ARTHUR HITCHCOCK ORCUTT AND JOHN WILDSMITH SNARRY. U. S. 1,749,258, March 4, 1930. In grinding and other machine tools, the combination comprising a vertical guide, a slide movable on the guide, a bell crank

lever pivoted on the slide, a balance weight, flexible means for securing the balance weight to one end of the bell crank lever, and a radius rod having one end attached to a fixed pivot, the other end of the radius rod being attached to the other end of the bell crank lever, substantially as described.

Valve grinder. EDWARD HENRY PETERSON AND WILLIAM H. ODLUM. U. S. 1,749,300, March 4, 1930. In a valve grinder, the combination of an elongated supporting casing having a pair of tranverse bores with a valve-actuating shaft rotatably mounted in one of the bores and extending in the direction of the longitudinal axis of the casing, a counterbore about the shaft, a pair of washers in the counterbore, ball bearings between the washers in the counterbore, an annular shoulder carried by the shaft for engaging one of the washers, a pinion carried by the shaft in the casing, a sheet metal segmental gear having radial teeth on its periphery rotatably mounted in the casing in vertical position to engage the pinion at right angles thereto, a second shaft rotatably mounted in the other bore of the casing, a crank lever fixedly secured to the second shaft, a crank for actuating the second shaft, pivot posts riveted to the crank lever and to the segmental gear, and a connecting link pivotally secured to the crank lever and the segmental gear by the pivot posts, the crank lever being of less length than the radial distance of the pivot post on the segmental gear from the axis of the segmental gear.

Grinding apparatus. RODGER J. EMMERT. U. S. 1,749,329, March 4, 1930. Grinding apparatus comprising in combination a frame, a grinding wheel non-adjustably supported on the frame, a conveyer including means for moving work-pieces into engagement with the grinding wheel, and a guideway adjacent the wheel to hold the work-pieces in proper alignment therewith, the guideway comprising spaced blocks having tracks upon which the work-pieces are slid toward the wheel and spring-loaded members adapted to engage the work-pieces and maintain them in proper engagement with the tracks.

Abrading machine. WALTER B. WARD. U. S. 1,749,898, March 11, 1930. An abrading machine, comprising a shaft-bearing bracket belt abrading mechanism disposed above the bracket, arms mounted in the base and adjustably extending laterally therefrom at right angles to the line of the shaft bearings, each of the arms being bent upward substantially at right angles to the lateral portion thereof, one of the upward extensions being hollow and vertically disposed, and the other thereof inclined toward the vertical one and secured to the same near the upper end thereof as a brace, a rod disposed in the vertical extension and longitudinally adjustable with reference thereto, means for locking the rod with reference to the extension, a lateral extension from the rod, and a steady rest mounted on the extension.

Truing device. HAROLD W. HOLMES. U. S. 1,750,175, March 11, 1930. A grinding machine comprising a grinding wheel, a guard around the wheel, a truing mechanism mounted upon the guard including a cylindrical support, an arm slidably mounted on and arranged to turn about the axis of the support, a dresser adjustably carried upon the opposite end of the arm and arranged to be pressed against the wheel by the action of gravity, means for limiting the movement of the dresser toward the wheel under the urge of gravity, means for adjusting the position of the dresser relative to the arm toward and from the wheel, and means for causing the dresser to move across the periphery of the wheel along a line substantially parallel to the axis of the wheel.

Grinding chasers. RALPH E. FLANDERS. U. S. 1,750,956, March 18, 1930. In a machine of the class described comprising a grinding wheel, a carriage movable substantially parallel to the axis of rotation of the wheel, a chaser holder movable transversely of the carriage to effect relative traversing movement between the cutting face of the wheel and the chaser lengthwise of the threads thereof, means for reciprocating the

holder, and means acting automatically between its traverses to move the carriage to cause successive traverses between the wheel and chaser to be effected on adjacent threads.

Gear-grinding machine. CHARLES H. SCHURR. U. S. 1,751,104, March 18, 1930. In a gear-grinding machine, a main frame, a grinding wheel supporting column on the frame, a planular faced grinding wheel rotatably mounted on the column, ways on the frame, a reciprocable slide on the ways, a work spindle rotatably mounted on the slide, means for reciprocating the slide and oscillating the work spindle to cause a work gear mounted on the work spindle to roll on an imaginary conjugate rack, means for adjustably moving the column on the frame and for adjustably moving the planular face of the grinding wheel on the column to bring the wheel plane into coincidence with a tooth face of an imaginary right hand or left hand helical rack of helical angle from zero degrees upward.

Grinding machine. ROGER N. HEALD, WALDO J. GUILD, ALFRED P. BURNS, AND GEORGE E. GARNO. U. S. 1,751,203, March 18, 1930. In a grinding machine, a reciprocating table, a wheel-dressing device having its point normally out of the path of the grinding wheel, mechanism adapted, when actuated, to move the dressing point into the path of the grinding wheel, a cam member to actuate the mechanism, and electromagnetic means for connecting the reciprocating table to the cam member.

Grinding machine. T. G. MARPLE. Brit. 323,236, Feb. 19, 1930. A grinding machine comprises one or more grinding wheels, polishing mops, etc., means for rotating the grinding wheels, etc., about their own axes, means for rotating them about the axis of the article to be treated and means for adjusting them in a radial direction comprising longitudinally-movable members and links connecting the members with the radially-movable bearings of the grinding wheels, etc.

Grinding or turning crank pins, etc. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 323,437, Feb. 26, 1930. In a grinding or abrading machine of the type in which the work, such as the outside crank pin of a locomotive driving wheel, is held stationary and trued by a grinding wheel mounted on a rotary head, the grinding spindle is arranged at an angle to the crank pin axis and the periphery of the wheel is correspondingly bevelled so that the inner portion of the pin may be trued without interference from the projecting end of the axle.

Turning and grinding machines. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 323,441, Feb. 26, 1930. Turning and grinding lathes, particularly those for locomotive driving wheels and axles, are provided with driving plates fitted with adjustable balance weights. The driven plate has a hub on which are pivoted arms carrying oppositely disposed balance weights, connected by links to a nut on a radial adjusting spindle. Studs pass through slots in a cover plate to lock the weights after adjustment. The nut may carry an indicating pointer.

Resurfacing loom shuttles. G. FORSHAW. Brit. 323,587, Feb. 26, 1930. A machine for resurfacing worn loom shuttles consists of a wheel faced with sand paper, etc., or a cutting wheel, and a table upon which is mounted a hinged rest adapted to support the shuttle.

Internal grinding machines. K. JUNG. Brit. 323,694, Feb. 26, 1930. In an internal grinding machine, wherein the grinding wheel is trued prior to taking the finishing cut on the work, the work and a truing diamond, or other tool are mounted on a rotatable head so that the work can be moved from the grinding wheel, and the diamond brought into position to operate on the grinding tool.

Grinding bodies of revolution. S. SOKAL. Brit. 323,700, March 5, 1930. In a centerless grinding machine the regulating wheel is driven by the work-piece by friction. A grinding wheel is driven from an electromotor and is mounted on a carriage with rough

and fine adjustment devices. The regulating wheel carried in a swinging frame, adjustable on a carriage, is rotated by friction from the work-piece and is mounted on a shaft geared to a centrifugal brake which retards the wheel when a predetermined speed is reached. A fluid pressure or electrically operated brake may be fitted. For dealing with conical work-pieces the regulating wheel is driven through a clutch before the work-piece is inserted and when the desired speed of rotation is reached the clutch is operated to cut out the positive drive. The regulating wheel carriage is adjustable by a screw. The work-support is adjusted by a screw and is locked by a wedge device.

Grinding wheels. R. G. SNOW. Brit. 323,942, March 5, 1930. In a segmental grinding wheel having the abrasive sectors projecting axially on both sides of the wheel frame, so that both end faces of the sectors are usable for grinding parallel surfaces, axial movement of the sectors is prevented by a circumferential tongue and groove engagement between the sectors and a clamping piece, cushioning pads being used between engaging parts.

Art and Archaeology

Measuring gray content and tinge of glasses. A. RUSS AND M. THOMAS. *Sprechsaal*, **62** [50], 924–28 (1929).—A process is developed with the help of which it is possible to measure rapidly and accurately the gray content and the tinge of glasses. The apparatus is simple and handy and therefore is especially suitable for research work in glass factories. By critical examinations of the data collected one can deduce general conclusions on the activity of decolorizing agents, the influence of the furnace action, etc. Some examples are quoted. M.V.K.

New art work in glass. WILHELM MOUFANG. *Sprechsaal*, **62** [51], 944–47 (1929).—Interesting and original effects have been obtained by new methods of decorating glass. Figures carved from solid glass blocks or cast from molds, designs cut in glass with diamonds, engraved plates and platters, and new kinds of polishing are illustrated. M.V.K.

New directions for practical glass etching. WALTER MEYER. *Chem.-Tech. Rundschau*, **44**, 1469, 1519 (1929).—Formulas are given for etching compositions to be used in production of plain frosted or designed etched glass and their methods of application. The acids consist of various combinations and concentrations of NH_4F, $(NH_4)_2SO_4$, HF, and H_2SO_4, depending upon the results desired. To prevent spreading in fine designs the acids are compounded with dextrin, glue, gum arabic, etc. Marginal waxes consist of asphalt gums, waxes, and turpentine oil. (*C.A.*)

Elimination of fabrication defects in manufacture of art pottery. C. H. *Keramos*, **8** [24–25], 913–18 (1929).—Methods of preparation of bodies, glazes, engobes, and colors for the manufacture of art pottery are described. The effects of firing conditions and kiln gases on the glazes and colors are discussed. F.P.H.

Ceramics adapts new expressions. BLANCHE NAYLOR. *Design*, **31** [10], 185–88 (1930).—Occult balance in design and symmetry in form predominate. Dynamic and mechanistic motifs are used giving definite feeling of progression. Colors have come to be flatter, contrasts are achieved by set-backs, tiers, and changing planes rather than by a combination of hues. Every method is being used to achieve variety of finish, the manner of execution depending upon the design. Art which forces unnatural limitations upon its materials defeats its own purpose. Illustrated. E.B.H.

Stained glass at Rochester. ANON. *Amer. Mag. Art*, **20** [11], 652–54 (1929).—The Memorial Art Gallery, Rochester, N. Y., has installed in a gallery adjoining its Fountain Court three examples of 13th Century French Gothic stained glass. This

gift of James Sibley Watson includes a complete lancet window from the Bourges region and a pair of quatrefoil medallions by the "Master of Sainte-Chappelle" from Paris. E.B.H.

New mosaic pavement at the National Gallery. BORIS ANREP. *Illus. London News*, **175**, 882–83 (1929).—The pavement mosaics on "The Pleasures of Life" are illustrated. H.H.S.

English glass pictures. FRANK DAVIS. *Illus. London News*, **175**, 868 (1929). H.H.S.

American pavilion at Venice. WALTER L. CLARK. *Amer. Mag. Art*, **20** [12], 714 (1929).—The Grand Central Galleries, Inc., of New York announce a project sponsored by its president, Walter L. Clark, to insure suitable representation of American art in the great Biennial Expositions in Venice. An adequate building as headquarters for a permanent exhibition is to be erected. The exhibitions are international in scope but heretofore the U.S. has had no pavilion as other nations have, also no government appropriation, but was assembled by the American Federation of Art. E.B.H.

Mosaic and stained glass in the present day. O. GEHRIG. *Glastech Ber.*, **7** [1], 23–24 (1929); *Diamant*, **50** [34], 704 (1928).—The work being done by the workers of stained glass in Germany is briefly discussed and the firms doing this sort of work at present are enumerated. Illustrated. E.J.V.

Ceramic ware in the Bavarian National Museum. MICHAEL BIRKENBIHL. *Sprechsaal*, **62** [46], 858–60 (1929).—B. gives a detailed description and a historical outline of the ceramic treasures in the Bavarian National Museum. In the 17th Century the faience industry reached its greatest height and produced a quantity of magnificent pieces. The Museum has a unique collection of Italian majolica of the 16th Century. Illustrated. M.V.K.

Glass collection of the Austrian Museum for Art and Industry, Vienna. IGNAZ SCHLOSSER. *Glastech. Ber.*, **7** [8], 323–27 (1929).—The collection of art glass to be found in the Austrian Museum contains specimens dating back as far as the 14th Century. Various outstanding specimens are described. Illustrated. E.J.V.

Arts and crafts in the Near East. MABELL S. C. SMITH. *Design*, **31** [10], 191–94 (1930).—At Hebron, Palestine, are the oldest glassworks in the world dating from the 5th Century which still retain that era's methods and equipment. In Jerusalem, Kutahia pottery is made. Illustrated. E.B.H.

Development of faience and majolica ceramics. TH. WOLFF-FRIEDENAU. *Sprechsaal*, **62** [52], 963–65 (1929).—W. gives a historical outline of this highly artistic branch of ceramics; its beginning in the 16th Century in Italy, its migration to France, the new impulse that it received there, and its spread from France to Germany and other countries. The French work is famous for the bright colors of the glaze, especially its Turkish blue which is called by its discoverer "Bleu de Deck." W. gives a list of the most important factories in Europe which produce this kind of ware. M.V.K.

Business pots in Roman London. QUINTIN WADDINGTON. *Daily Telegraph*, Nov. 12, 1929.—Excavations at Moorgate have unearthed jars of red Samian ware stamped with the name of the tradesman, Lucius Julius Senis. The jars were imported from Gaul. H.H.S.

Paleolithic "Pompeii" in Moravia. KARL ABSOLON. *Illus. London News*, **175**, 881 (1929).—Continuing account concerning the mammoth hunters of Central Europe, 17 photographs. See *Ceram. Abs.*, **9** [4], 253 (1930). H.H.S.

Maya country from the air. A. V. KIDDER. *Discovery*, **11**, 8–11 (1930).—The first aerial survey of Maya ruins was made in October, 1929, by K. in conjunction with the Lindberghs. Ancient temples hitherto unknown were discovered. H.H.S.

Sixth-century floor mosaics at Jerash. JOHN CROWFOOT AND IGNAZ REICH. *Illus.*

London News, **175**, 896 (1929).—Colored illustrations are given of the topographical mosaics found at Jerash, in Trans-Jordan, by the joint expedition of Yale Univ. and the British School of Archaeology in Jerusalem. H.H.S.

New light on ancient Ur. M. E. L. MALLOWAN. *Nat. Geog. Mag.*, **57**, 94–130 (1930).—The excavations at the city of Abraham are described. H.H.S.

Eastern origins of Christian art. PERCY DEARMER. *Nineteenth Century*, **106**, 828–34 (1929).—The revolutionary change that has come over our knowledge of the art of Christendom during the last 19 centuries is the discovery that we owe our origins neither to Greece nor to China, but to points between, mainly to Persia. Strzygowski is the pioneer of this knowledge. H.H.S.

Polychrome vases from Centuripe. G. M. A. RICHTER. *Bull. Met. Mus. Art*, **24** [12], 326–28 (1929).—The Museum owns four vases, representative examples from Centuripe. There are 39 known specimens of this ware from eastern Sicily and the majority are in the museums of Syracuse and Palermo. The outstanding characteristics of this ware are the fantastic shapes, relief ornaments, and the polychrome scenes. These scenes consist of human figures in vivid tempera colors and are practically paintings of the Hellenistic period. The best preserved example is in the form of a bell krater without handles, set on a high foot and surmounted with a domed lid. The painted scene consists of four statuesque figures which stand out in vivid reds, blues, yellows, purples, white, and flesh colors, against a bright rose background. Another specimen has an undetachable lid worked in one piece with the receptacle and a separate finial and foot. This is not well preserved, as there are only faint traces of the decoration showing. A third piece is in krater form with handles. The painted scene is well preserved and the lid has been restored. The fourth piece is a kotyle, or deep cup, with two large handles, a domed lid, and a third part which may be its foot. There are traces of three figures in the painted scene. Vases of this type have been found in cemeteries around Centuripe, with Hellenistic terra cottas and jewelry, and with coins dated from the third century B.C. to early imperial times. A.A.A.

An Etruscan cauldron. CHRISTINE ALEXANDER. *Bull. Met. Mus. Art*, **25** [1], 13–15 (1930).—The custom of burying the dead in a subterranean room, surrounded by the treasures they had enjoyed on earth, is responsible for most of the present knowledge of the life of the Etruscans. Their history was not recorded although they were a mighty people and dominated the northern and central part of Italy before the rise of the Roman power. Near this great people lived smaller Italic tribes of obscure fortune. Among these were the Capenates. A cauldron and stand of pottery from Capena is shown in the Room of Recent Accessions. It is of reddish clay covered with a black glaze, brown in places, and is an imitation of such works as the bronze cauldron decorated with animals and monsters from the Regolini-Galassi tomb. The decoration is incised and a red application, presumably ocher, has been rubbed into the incisions. Lionesses, water fowl, and a winged feline in the act of swallowing a human being, a winged goat, and a smaller goat with a bird above it, comprise most of the decoration. The shape of the cauldron is Italic but it is Greek in feeling. The decoration is Graeco-Oriental. The material known as impasto is an improved wheel-made variety of the primitive hand built ware of that name. A.A.A.

Stewart bequest. PAULINE SIMMONS. *Bull. Met. Mus. Art*, **24** [12], 316–18 (1929).—The blue and white Chinese porcelains in the William Rhinelander Stewart bequest are of the K'ang Hsi, Yung Chêng, and Ch'ien Lung periods, which have supplied the bulk of the finest Chinese porcelains in Western collections. This collection is largely made up of so-called soft-paste specimens, distinguishable from hard-paste porcelain by its extremely light weight, soft creaminess of texture, and its delicate crackle. The decoration is usually underglaze blue. The collection is made up of 116

pieces all of cabinet size. Among the larger pieces are vases, bowls, and jars of unusual shape and design, all with the sharp clear blue peculiar to hard-paste porcelain of the K'ang Hsi period. There are also some excellent specimens of the delicate ivory tinted crackling on the larger soft-paste pieces. The small jars and snuff bottles are more delicate in modeling and design and are nearly all soft-paste specimens. A.A.A.

Chinese glass, Han and T'ang periods. ALFRED SALMONY. *Int. Studio*, **95** [394], 21–23 (1929).—In the Han period, the Chinese made glass paste only and its production continued until glass blowing was done in the T'ang period. It was supposed until recently that the Chinese imported Roman and Syrian glass early in the Christian era but knew nothing of glassworking until the 5th Century. Discoveries of tooth-shaped glass pendants in prehistoric tombs of Japan, evidently imported from the mainland, seem to contradict this supposition. Chinese literature of the Han period mentions glass as introduced from the west. Opposing this, finds of buttons and fragments show a modest output of glass paste in China. This paste-like jade was highly prized as ornaments for the dead. T'ang glass was considered superior to ceramics. For the most part the special properties of glass were overlooked but in hollow pieces their use began to be recognized. A glance at the history of Chinese ware teaches us that thinness and transparency so dear to Europeans were not always considered in China, but rather simplicity and suitability of form. Proof of the supposition of the early Chinese glass industry could be negative proof that nothing similar had been created in the West. Illustrated. E.B.H.

BOOKS

Munsell Book of Color. MUNSELL COLOR CO., INC. Baltimore, Md. Standard ed., $50.00; abridged ed., $12.50. *Brick Clay Rec.*, **76** [5], 340 (1930).—The standard edition presents 400 carefully standardized colors mounted in uniform charts which illustrate the three psychological attributes of color, hue, value, and chroma. The color charts are preceded by a brief general description of the system devised by A. H. Munsell for coördinating the three color qualities mentioned, and instructions for the use of the standard color charts in the analysis and specification of colors. The book also contains a section devoted to traditional color names (such as pink, orange, brown, etc.), which shows the relationship of these names to the Munsell System of Color Notation. Finally, there is a dictionary of color terms which presents the best modern thought on this subject. The color charts in the standard edition are divided into several groups. There are 10 charts of constant hue which show measured steps of chroma at 7 value levels in one particular hue; 6 charts of constant value which show 20 hues in measured steps of chroma radiating from the neutral gray axis on one particular value level; 8 charts of constant chroma which show the sequence of hues at 7 levels of value but at one particular strength of chroma; and 2 special hue charts which show the sequence of 20 hues at 7 levels of value, each hue being represented at the maximum of chroma which it attains at each level of value. The abridged edition is especially designed to be a handy reference book for those who are already familiar with the Munsell Color System. E.J.V.

Excavations at Duro-Europos. Edited by P. O. BAUR AND M. I. ROSTOVTSEFF. preface by J. R. ANGELL. 88 pp. Yale Univ. Press, New Haven, 1929. Price $1.00, *Times Literary Supp.*, **28**, 1059 (1929).—The preliminary results of the excavations now in progress under the joint auspices of the French Academy of Inscriptions and Letters and of Yale Univ. are here reported. Mussulman pottery found throws light on the later periods of the city. H.H.S.

Practical Color Simplified. WILLIAM J. MISKELLA. Finishing Research Laboratories, Inc., Chicago, Illinois. Reviewed in *Brick Clay Rec.*, **76** [5], 324 (1930); see *Ceram. Abs.*, **8** [3], 170 (1929). E.J.V.

Place of Economy in Art. HERBERT LLEWELLYN SMITH. 16 pp. British Inst. of Industrial Art, London, 1929. Price 6d. The inaugural lecture delivered at the London Central School of Arts and Crafts is given. H.H.S.

How to Observe in Archaeology. FLINDERS-PETRIE, *et al.* 2nd ed. 120 pp., illustrations and diagrams. British Museum, London, 1929. Price 2s 6d. Reviewed in *Geographical Jour.*, **74**, 596 (1929).—The first part gives instructions on outfit, recording, photographing, preserving, packing, etc. The second tells of archaeological remains that have been, and may still be, found in Greece, Asia, etc. An appendix deals with the law on antiquities prevailing in different countries. H.H.S.

PATENTS

Design for tray. JESS CLAIR KELLY. U. S. 80,625, March 4, 1930.

Design for tumbler, etc. EDWARD E. BARTLETT. U. S. 80,596, March 4, 1930.

Design for closet. CHARLES R. CRANE. U. S. 80,606, March 4, 1930.

Design for bottle, etc. WALTER D. TEAGUE. U. S. 80,708 and 80,709, March 11, 1930.

Design for goblet, etc. EDWARD J. SCHAUB. U. S. 80,747, March 18, 1930.

Design for plate. URASABURO TOMITA. U. S. 80,754 to 80,757, March 18, 1930.

Ceramic masses. VEREIN FÜR CHEMISCHE UND METALLURGISCHE PRODUKTION. Ger. 486,856, June 11, 1925. Ceramic masses are obtained by kneading TiO_2 with MgO or MgO-CaO, molding, and sinter-firing. (*C.A.*)

Cement, Lime, and Plaster

Studies on thermochemistry of compounds occurring in system CaO–Al_2O_3–SiO_2. I. Heat of solution of calcium oxide in hydrochloric acid. T. THORVALDSON, W. G. BROWN, AND C. R. PEAKER. *Jour. Amer. Chem. Soc.*, **51** [9], 2678–82 (1929).—The heat of solution of calcium oxide in HCl 200 H_2O at 20°C was found to be 46.50 cal./mol. The heat of solution was found not to be materially affected by the temperature of ignition between 800°C and 1200°C. R.G.M.

Crystal structure of tricalcium aluminate. F. A. STEELE AND W. P. DAVEY. *Jour. Amer. Chem. Soc.*, **51** [8], 2283–93 (1929); see *Ceram. Abs.*, **9** [3], 154 (1930). R.G.M.

Steam curing of Portland cement mortars. T. THORVALDSON AND G. R. SHELTON. *Tonind.-Ztg.*, **53** [102–103], 1804 (1929); *Pit and Quarry*, **19** [11], 89 (1930); for abstract see *Ceram. Abs.*, **8** [12], 865 (1929). M.V.K.

Calcium sulpho-aluminate cement. SOC. ANON. DES CHAUX ET CIMENTS DE LAFARGE ET DU TEIL. *Pit and Quarry*, **19** [11], 89 (1930).—A hydraulic binding material consists of an intimate mixture of aluminous cement, prepared by melting, clinkerizing, or fritting, and calcium sulphate in dry form, such as gypsum, anhydrite, or more or less fired plaster. The proportions are preferably such that all the alumina is converted into calcium sulpho-aluminate and the mixture usually contains from 20 to 50% of calcium sulphate. Other proportions of from 5 to 95% of either ingredient may also be used. The calcium sulphate is added to the raw material of the aluminous cement, the mixture being then heated without melting. E.P.R.

Effect of calcium chloride on cement. C. R. PLATZMANN. *Chem.-Ztg.*, **53** [477–78], 494–96 (1929); *Pit and Quarry*, **19** [8], 84 (1930).—Cement or concrete mixed with a solution of calcium chloride sets more rapidly than when mixed with water, and, owing to the greater evolution of heat in the initial stages of setting, a more coarsely crystalline structure is obtained, resulting in higher initial tensile and compression strength. During aging for 1 to 3 months the compression strength of cement mixtures containing calcium chloride increases more slowly than that of chloride-free mixtures, but is always

5 to 20% greater. The tensile strength of the chloride mixtures, however, decreases appreciably after 1 month, and is finally less than that of water mixtures. Calcium chloride is a suitable addition agent for cement mixtures made in frosty weather, owing to the rapid setting and heat evolution produced. E.P.R.

Rapid determination of lime in cements. ROGOZINSKI. *Zement*, **18**, 51 (1929); *Rock Prod.*, **33** [4], 93 (1930).—R. describes an operating control method for the quick determination of the lime content of Portland cement. Mix 0.65 g. of −254-mesh cement with 5 cc. of water in a 400-cc. beaker and, while stirring, add 20 cc. of $N/1$ HCl. Other weights of cement may be used, but too great a quantity must be avoided for the end-point of the titration is not sufficiently sensitive. To accelerate the dissolving of the cement, excess HCl up to 40 cc. may be used. If this is done 20 cc. of $N/1$ NaOH must be added before dilution with boiling water. Stirring is continued until the solution is complete; the beaker is then covered with a watch glass and left to digest at a moderate heat for 15 minutes. The solution is diluted to 200 cc. with boiling water and boiled one minute; a few drops of phenolphthalein solution are added, and the mixture is titrated at once with $N/2$ NaOH. Approximately normal solutions of the reagents may be used. As the end-point is approached, NaOH is added cautiously and the beaker is agitated while precipitation takes place. A filter paper is placed behind the beaker and the coloration of the lower part of the paper (back of the layer of liquid) is compared with that of the upper part. When the liquid assumes a noticeable rose color the burette reading of the NaOH is taken. For accurate results several samples may be run. The lime content is figured as follows: Assume that 0.65 g. of cement, the lime content of which has been determined by analysis, requires 18 cc. of NaOH for titration, then by the test method above treat 0.6552 g., 0.6348 g., and 0.6196 g. of the same cement, *i.e.*, quantities which differ in their lime content by 0.01 g., 0.02 g., etc., corresponding to 1%, 2%, etc., of CaO. These require for titration 9.3, 10.7, and 11.4 cc. of NaOH, respectively. A difference of 1% in lime content of the cement corresponds, therefore, to 0.7 cc. of NaOH, or 0.1% CaO to 0.07 cc. NaOH. In this manner a table can be prepared from which % CaO can be read directly. For example, if 10.35 cc. NaOH are used to titrate a cement, its lime content is 65.5%. After a little practice the CaO content of a cement can be determined with an accuracy of 0.1%. W.W.M.

Hydraulic lime for masonry construction. E. W. LANE. *Jour. Assn. Chinese and Amer. Engrs.*, **10**, 19–34 (1929); *Pit and Quarry*, **19** [10], 87 (1930).—Because of its durability, cheapness, and strength, Portland cement has in America monopolized the field of cementing material in all forms of hydraulic construction and most all masonry structures of magnitude. In countries such as China, due to conditions of transportation and labor cost, it may not always be the best material to use. L. recommends the consideration of artificial hydraulic lime made from fired lime and clay. Ordinary lime has no "hydraulic properties." It is soluble in water and cannot be used for hydraulic construction. Lime fired from limestone with a small content of alumina and silica, natural hydraulic lime, does have hydraulic properties, but such stone is not of general occurrence. In the 19th Century, Vicat discovered that mixing slaked common lime with a small portion of clay and refiring it gave an artificial hydraulic lime that could be slaked and used as with ordinary lime. This led to Aspdin's invention of Portland cement. Vicat's material can best be made by firing clay in a kiln, as brick are made; the fired clay pulverized and thoroughly mixed with slaked lime and sand to make mortar, and such mortar mixed with broken stone or brick to make concrete. E.P.R.

Action of sulphates on Portland cement. ANON. *Pit and Quarry*, **19** [12], 97 (1930); for abstracts see *Ceram. Abs.*, **9** [1], 14; [2], 84 (1930). E.P.R.

Shells and clay as raw materials. T. K. KNOX. *Pit and Quarry*, **19** [7], 26–36; [8], 27–39 (1930).—The Trinity Portland Cement Co. utilizes shells to provide the calcium and clay for silica and alumina; both are transported to the plant by barges. The shells are dredged from reefs in Galveston Bay, and are washed to remove the sand. E.P.R.

Recent research on cement and concrete. OTTO GRAF. *Pit and Quarry*, **19** [8], 49–53 (1930); *Rock Prod.*, **33** [3], 75 (1930); for abstract see *Ceram. Abs.*, **9** [4], 259 (1930). E.P.R.

Fine grinding of Portland cement materials. ALTON H. BLANK. *Rock Prod.*, **33** [5], 64–65 (1930).—B. experimented with various sizes and shapes of grinding media for fine grinding of cement materials and gives the test procedure and the data obtained. W.W.M.

Packing of cement. H. LUFTSCHITZ. *Rock Prod.*, **33** [3], 75 (1930); see *Ceram. Abs.*, **9** [3], 157 (1930). W.W.M.

Water requirement of cement mortar. HANS KÜHL. *Zement*, **18**, 45 (1929); *Rock Prod.*, **32** [26], 98 (1929); for abstract see *Ceram. Abs.*, **9** [3], 154 (1930). W.W.M.

Tests on Hungarian bauxite cement. EUGEN KISS. *Organ Fortschritte Eisenbahnwesens*, **84**, 376–78 (1929); reviewed in *Pit and Quarry*, **19** [12], 97 (1930).—Bauxite cement (high alumina cement) is produced in Hungary by the Tataer cement plant under the name "Citadur," which was put on the market during 1928. It is a slow-setting cement of high initial strength, the strength at 2 or 3 days reaching or passing that of Portland cement at 28. Its resistance to chemical action is greater than Portland cement. The composition of the cement is as follows: insoluble 2%, loss on ignition 0.3%, SiO_2 4.32%, Al_2O_3 42.25%, Fe_2O_3 14.11%, CaO 36.82%, MgO 0.11%, SO_3 0.54%. The percentage retained on a 900-mesh per sq. cm. screen (75-mesh) is around 0.1%, and that on 4900-mesh per sq. cm. (175-mesh) 3%. Setting begins at 4 hrs. 20 min. to 5 hrs. 50 min. in air and 5 hrs. to 5 hrs. 45 min. under water, and ends at 6 hrs. 30 min. to 6 hrs. 50 min. in air and 6 hrs. 10 min. to 6 hrs. 35 min. under water. The resistance to chemical action, especially sulphate and chloride solutions and organic acids, is considerably greater than Portland cement. The Citadur is very sensitive to admixtures of lime or Portland cement; with a few per cent of lime or Portland cement (or the admixture of Citadur to Portland), the mix becomes rapid-setting. Tests are now in progress on expansion and contraction and on properties of elasticity. Citadur is about 50% more expensive than the Portland cement available in Hungary and K. concludes that its use is justified only in cases where the time saved in construction has an economic value offsetting its higher cost, and for work where its higher strength and greater resistance to chemical action are essential. E.P.R.

Blast-furnace cements. O. REBUFFAT. *Giorn. chim. ind. applicata*, **11** [8], 353–55 (1929).—The manufacture of Portland cements has been recently begun at Portoferraio and Bagnoli in Italy which makes use of the enormous quantities of slag and scoria from the furnaces in the vicinity. There are two kinds of these cements classified according to the quantity of the slag which is ground with the clinker. In Germany they are called (1) ferro-cement 70% clinker, 30% slag, and (2) blast-furnace cement in which there is a greater percentage of slag, sometimes amounting to 85%. This distinction in blast-furnace cements was unfortunately omitted in the recent standardization of the blast-furnace slags by the Italian government. M.V.K.

Chemical reactions in Portland cement mortars. G. KATHREIN. *Zement*, **18**, 1098–1102 (1929).—The aggregates used are finely-ground quartz, pumice, orthoclase, augite, calcite, and kaolin. One series of mortar specimens was cured for 35 days in air at 20°, another had 20 days in air and 15 days at 70°, and the third had 33 days in

air and 2 days in an autoclave under 20 atmospheric pressure. The interaction between the mineral aggregate and the cement was followed by the decrease in the free lime present in the mortar. W. E. Emley's chemical method and A. H. White's microscopic test were used. At room temperatures only pumice and kaolin reacted, pumice reducing the free CaO to $^1/_4$ its original value. At 70° all aggregates combined with the lime, the pumice and kaolin most actively. Under autoclaving conditions the augite and calcite reacted slightly, orthoclase about 85% and the pumice, kaolin, and quartz 100%. The chemical and microscopic methods gave results in good agreement. (*C.A.*)

Method of studying reactions in a Portland cement kiln. W. N. LACEY AND H. WOODS. *Ind. Eng. Chem.*, **21** [11], 1124–26 (1929). R.G.M.

Water-glass as a protection for concrete and stones. C. R. PLATZMANN. *Tonind.-Ztg.*, **54** [5], 73–75 (1930).—P. takes up the different methods which have been proposed by investigators beginning with Schott in 1871 up to the present time, for the use of water-glass as a protective agent and a hardening agent for concrete. The conclusions are (1) water-glass as a protective agent for concrete is effective only when applied to hardened concrete, and even then its use is problematic as its efficiency depends very much on the kind of cement; (2) use of water-glass to hasten the setting time of slow-setting cements is to be avoided as this method, as well as the use of soda solutions, lowers the solidity of the concrete and causes objectionable efflorescences. M.V.K.

Structure and chemical resistance of concrete. RICHARD GRÜN. *Tonind.-Ztg.*, **53** [101], 1781 (1929); for abstract see *Ceram. Abs.*, **9** [4], 258 (1930). M.V.K.

Cement technology in 1929. C. H. SONNTAG. *Pit and Quarry*, **19** [7], 37–38 (1930).—The different steps and methods in cement technology are discussed individually. E.P.R.

Oakfield Gypsum Products Corp. plant. W. E. TRAUFFER. *Pit and Quarry*, **19** [10], 63–68 (1930).—The Oakfield Gypsum Products Corp., near Oakfield, N. Y., has a capacity of 300 T. per day of finished stucco, wall plaster, and plaster of Paris. The working details of the plant are discussed. E.P.R.

New cement plant in New South Wales. ANON. *Pit and Quarry*, **19** [10], 48 (1930).—The first unit of Southern Portland Cement, Ltd., Berrima, New South Wales (Australia), was put into operation with a capacity of 750,000 T. of cement a year, and a second unit of similar capacity is to go into operation soon. E.P.R.

Gypsum as a constructional chemical. G. M. THOMSON. *Can. Chem. Met.*, **14** [2], 43–44 (1930).—The physical and chemical properties of gypsum are discussed. The preparation of anhydrite and plaster of Paris by different heat treatments of gypsum is described. The fabrication of most gypsum products is carried out by the conversion of the mobile plaster of Paris into its original form, gypsum, by the addition of water which is taken up to replace the lost water of crystallization. The romance of gypsum dates back 10,000 years or more to the date when gypsum plasters were put to use in Egypt as coatings or plasterings. The gypsum industry has had a rapid growth due to the fire-resisting requirements of the high buildings. As a building material, gypsum is unique in that it cannot be heated to a temperature higher than the boiling point of water until all of its crystallized water has been melted and evaporated. It has been demonstrated that a solid gypsum tile, 3 inches thick, when subjected on one side to a temperature or 2100°F for three hours was less than 200°F on the unexposed side. Recognition of that characteristic has mainly caused the recent increase in its use as a structural material. E.J.V.

Quarrying and milling gypsum. G. L. LINCOLN. *Eng. Mining Jour.*, **129** [4], 181–84 (1930).—Examples of modern practice and equipment in Michigan and Illinois. E.C.C.

BOOK

Use of Calcium Chloride or Sodium Chloride as a Protection for Mortar or Concrete against Frost. W. N. THOMAS. Dept. of Scientific and Industrial Research. H. M. Stationery Office, London, England. Price 9d. Reviewed in *Can. Chem. Met.*, **14** [2], 56 (1930). E.J.V.

PATENTS

Shaft kiln with continuous draw apparatus. WILHELM MUELLER. Ger. 482,111; *Rock Prod.*, **33** [3], 75 (1930).—A gas-fired shaft kiln is provided with endless conveying grates located beneath each discharge opening. The grates are operated by a common drive and deliver the material toward the center beneath the kiln, and then to the bins for large and small size fired material. W.W.M.

Cooler for rotary cement kilns. ANON. Ger. 484,322; *Rock Prod.*, **33** [4], 93 (1930).—It has been impossible to cool completely the clinker discharging from the rotary kiln into the cooling drum, and at the same time preheat fully the combustion air passing through this drum because the combustion air introduced axially could be preheated only at the surface of the hot clinker passing through the drum. To solve this problem introduce the cooling air where the clinker accumulates while the drum is rotating by designing the cooling drum wall like a grate. The grate-like drum wall permits the clinker dust to drop through to the stationary drum to be discharged by conveyers, so that it is not carried with the air into the kiln. The grate surface is suitably designed of grate bar carriers located parallel to the drum axis, in which the grate bars are inserted from the side. W.W.M.

Enamel

Raw and white ground coat. A. MALINOVSZKY. *Jour. Amer. Ceram. Soc.*, **13** [4], 277–84 (1930); for abstract see *Ceram. Abs.*, **9** [3], 163 (1930).

Opacifying effect of some fluorides in enamel mill additions. R. MELVILLE PEARCE AND R. M. KING. *Jour. Amer. Ceram. Soc.*, **13** [4], 272–76 (1930); for abstract see *Ceram. Abs.*, **9** [3], 162 (1930).

Clay application in enameling. EDWARD KETCHEM. *Ceram. Ind.*, **14** [3], 316 (1930).—Many enamel defects have been traced directly to the clay. Clay should have the following characteristics: (1) high plasticity, (2) white firing qualities, (3) freedom from organic matter, sulphates, chlorides, and carbonates, and (4) freedom from rock particles. Any number of clays from various localities are suitable for enamel flotation and give splendid results when used with certain frits. The proper suspension of enamel frit does not depend upon the clay alone but is influenced by several things: (1) kind of clay used, (2) its amount in the batch, (3) kind and amount of electrolyte used, (4) specific gravity of the frit, (5) amount of water used during milling, (6) heat generated during milling, (7) solubility of frit in mill liquor, and (8) aging of the slip. F.P.H.

To prevent tarnish. ANON. *Black and White; Abrasive Ind.*, **11** [3], 32 (1930).—Many compounds used for wet grinding contain alkaline soaps. As soon as the ground parts leave the machine, they should be washed free from all traces of alkali. If the alkali is allowed to remain on the metal it will rapidly etch and tarnish the surface. After removing all traces of the cleaning compound with water, the parts should be dried and immediately slushed with rust preventive. Parts so slushed, will remain in perfect condition until the time required to use them in the assembled machine. E.P.R.

Antimony in enamels. HANS MELZER. *Glashütte*, **59** [47], 865 (1929).—It is often advantageous to add antimony to enamels, yet in some countries laws have been passed to prevent its use because of fear of food poisoning. Tests have shown that if

the pentoxide (Sb_2O_5) is used no soluble antimony is given up in dilute acids. But if the trioxide (Sb_2O_3) is used dilute acids will extract antimony and therefore it dare not be used in enamels for cooking utensils. L.T.B.

Cast iron for enameling. A. MÜLLER. *Iron and Steel Ind.*, **2**, 290 (1929).—An English abstract of M.'s paper in German. For abstract see *Ceram. Abs.*, **8** [12], 868 (1929). (*J.I.S.I.*)

Vapor degreasing process. ANON. *Can. Chem. Met.*, **14** [1], 42 (1930); see also *Ceram. Abs.*, **9** [3], 215 (1930). E.J.V.

Nickel and chromium in enamel. A. LABO. *Industria*, **43**, 135–37 (1929); *Giorn. chem. ind. applicata*, **11** [7], 1013 (1929). M.V.K.

Resistance of enamels to percussion. ANON. *Emaillewaren-Ind.*, **6** [51], 419–20 (1929).—Experiments were made to ascertain the relation of the thickness of metal plates to the resistance to percussion of ground-coat enamels. Metal plates of various thicknesses were coated with the same quantity of enamel, a thickness of 0.15 mm. on each side, and fired simultaneously. The testing apparatus consisted of a steel ball weighing 110 g. which fell within a tube of 50 cm. length. Results: (1) A plate 2 mm. or more in thickness increased the resistance to percussion of the ground-coat enamel; (2) plates of less than 0.5 mm. thickness were also favorable to the resistance; (3) plates having between 0.50 and 2 mm. thickness gave negative results. M.V.K.

Flexibility of enamels. ANON. *Emaillewaren-Ind.*, **6** [51], 420–21 (1929).—Manufactured enamels have a high resistance to pressure but lack flexibility. A composition for enamels should be found which would correct this defect and insure the following qualifications: (1) fusing temperature as low as possible; (2) resistance to pressure as great as possible; and (3) coefficient of expansion as high as possible. The addition of CaO, ZnO, SiO_2, or boric acid would tend to increase the flexibility, but would lower the resistance to pressure, as only SiO_2 has a resistance of slightly more than 1.0 (1.23). It is known that during melting, fine threads of enamels can be bent and also that very thin enamels are flexible. M.V.K.

Method for comparison of size of materials used in blast-furnace burdens. ANON. Bur. Mines, *Rept. of Invest.*, No. 2982, 4 pp. (1930).—The method employing screen analysis for measuring the average size of particle in a mass of finely-ground material is briefly described and results of application of the method on typical burdens at various plants are given. R.A.H.

Raw materials suitable for production of enamel. ANON. *Emaillewaren-Ind.*, **6** [48], 396–97; [49], 404–405; [51], 421–22 (1929).—Analyses are given of the composition of the raw materials used in the production of enamels (minerals, salts, oxides). Variations in their composition, which are allowable are as follows: (*A*) *Minerals.* (1) Quartz or quartz sand containing 99.8% SiO_2 is best, but ordinary sand may be used if the exact composition is known and can be regulated; SiO_2 not less than 97% and Fe_2O_3 not over 0.3% (for white enamel). (2) Feldspar; SiO_2 not under 56% and not over 75%, Al_2O_3 not under 15% nor over 20%, Fe_2O_3 not over 0.7%, CaO up to 1.5%, and moisture content not over 2%. (3) Clay should not contain lime or iron pyrite; Fe_2O_3 not more than 1%. (4) Calcite is used in such small quantities (not more than 10%) that its impurities are negligible. (5) Fluorspar should contain as much CaF_2 as possible. (6) Pyrolusite is used in very small quantities and its impurities are also unimportant. (7) Cryolite whether natural, synthetic, or mixed should contain approximately 40% AlF_3 and 55 to 57% NaF. (*B*) *Salts.* (1) Soda should not contain more than 1% chlorine and the moisture content should be carefully regulated (approximately 17%). (2) Borax; impurities are negligible. (3) In saltpeter the traces of chlorine disappear with fusion; iron content should be noted because of its color. (4) Sodium fluosilicate does not contain more than 2% impurities which are harmless,

with the exception of chlorine. (*C*) *Oxides.* (1) Cobalt oxide of 70% cobalt. (2) Nickel oxide. (3) Chromoxide. (4) Red lead used for majolica enamels. M.V.K.

Antimony-oxide-"Stibiox O." ANON. *Emaillewaren-Ind.*, **6** [50], 413–14 (1929).—The Deutschen Schmelz und Raffinier Werke A.-G., Gliesmarode-Braunschweig have prepared an antimony oxide which can be used as a substitute for tin oxide in the production of enamels. It is known as "Stibiox O" and is as pure as tin oxide and has the same coloring power, giving a pure white porcelain appearance. Its covering power is so great that one coating is sufficient in many cases. The addition of 4 to 5% "Stibiox O" to a nickel base gives a gray foundation which is well covered by one white coating. The cost is small: Rm 1.15 per kg. M.V.K.

Review of iron and steel literature for 1929. E. H. MCCLELLAND. *Blast Fur. Steel Plant*, **18** [2], 309–12 (1930).—A classified list is given of the more important books, serials, and trade publications during the year with a few of earlier date not previously announced. F.P.H.

New interchangeable chemical reaction kettle. ANON. *Can. Chem. Met.*, **14** [3], 41 (1930).—A new 500-gallon unit, said to be the largest standard glass-lined, all steel chemical reaction unit on the market, is being put out by the Pfaudler Co. It is suitable for handling all organic and inorganic acids, at practically all concentrations and temperatures, with the exception of hydrofluoric. Depending on whether or not heat is necessary, the kettle may be obtained in steam-jacketed or single-shell construction. Illustrated. E.J.V.

Straight-line production of stoves. F. L. FAUROTE. *Iron Age*, **125** [7], 493–98 (1930).—The plant of the Detroit (Mich.) Vapor Stove Co. is described. A flow sheet and illustrations of the enameling process show how hand work is virtually eliminated between press room and assembly. Continuous circular hearth furnaces and efficient conveying systems are the outstanding features of this plant. E.C.C.

PATENTS

Enamel. DEUTSCHE GOLD- UND SILBER-SCHEIDEANSTALT (vorm. Roessler). Fr. 665,966, Dec. 17, 1928. Substances such as compounds of Zr, Ti, and Sb to be used for rendering enamels opaque are first heated to a temperature above 1000°, *e.g.*, 1500°, whereby they are made practically insoluble in the enameling bath. (*C.A.*)

Enameling iron. SOC. CONTINENTALE PARKER. Fr. 666,810, April 3, 1928. Enamel is applied to Fe objects which have been "Parkerized," *i.e.*, dipped into a salt solution capable of transforming the surface of the Fe to form a film of strongly adhering insoluble salt of Fe. (*C.A.*)

Charging and operating means for rotary furnaces for melting enamels, etc. THEODOR J. VOLLKOMMER. Ger. 484,492, Nov. 29, 1927. (*C.A.*)

Glass

Effect of boric oxide on rate of melting and on some physical properties of colorless bottle glasses. V. DIMBLEBY, M. PARKIN, W. E. S. TURNER, AND F. WINKS. *Jour. Soc. Glass Tech.*, **13** [51], 248–58 (1929).—The value of boric oxide as a glass constituent to increase its thermal endurance, resistance to water, and chemical reagents and surface hardness is found to be limited to certain glasses and also to the amounts of the oxide used. In glasses of the soda-lime-silica type, boric oxide was introduced in two ways: (1) as borax in regularly increasing amounts between 0.5% and 2.5%, and (2) by reducing in successive stages, 10 parts soda ash from the batch and substituting 20 parts of borax. Rate of melting and elimination of seed increased with increase of boric oxide. G.R.S.

Effect of cullet on melting and working properties of potash-lead oxide-silica glasses. S. ENGLISH, G. A. GREEN, F. W. HODKIN, AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **13** [49], 37–48 (1929).—Glass was made from the following batch: sand 900, red lead 600, potash 300, potassium nitrate 48, and manganese dioxide 1. Two series of meltings with various proportions of cullet were carried out at 1350° and 1400°, in fireclay pots of the covered type. Pots were brought up to the temperatures noted before being charged. Those containing the most cullet required a longer time to attain once more the melting temperature after the charge was complete. Rate of melting was unaltered when less than 50% cullet was used; an increase over this amount required longer time for melting. The process of melting from batch seems to be a dual one, (1) the formation of mobile glass with a low silica content and (2) solution of remaining silica with increase of viscosity. Proofs were taken at the end of 12, 14, 16, and 18 hours to determine progress of refining. Working operations were begun 20 hours after the addition of the first charge. Results given in 2 tables show the following: Melts containing the most cullet became free from seed soonest, while the batches first melted remained seedy longest. At 1400°C the glass contained more seed than that made at 1350°C, secondary seeding being developed at the higher temperature. The glasses were cooled to 1250° for working. In practically every case, especially those melted at 1400° there was a viscous, waxy layer on the surface of the glass, which was removed by skimming, improving the glass but not removing all waves and cords. The surface became bad again fairly quickly. Viscosity increased with the proportions of cullet in the batch and the effect was more marked in the glasses melted at 1400° than at 1350°. The rate of setting increased with increase of cullet. In glasses melted at 1400° an increased cloudiness was noted as they were worked accompanied by separation of crystalline silica. G.R.S.

Use of boric acid in glass industry. F. H. ZSCHACKE. *Glashütte*, **59** [46], 846–48 (1929).—The recent decline in price of borax makes possible its more general use in the glass industry. It may be substituted for either SiO_2 or Na_2O whereby the time required for the melting operation is reduced. Likewise the temperature of melting is reduced. Such borax glasses are more resistant to chemicals than ordinary glass. It decreases the coefficient of expansion of glass. The breaking strength is increased by the addition of borax, but such glasses are harder to clarify than non-borax containing glasses. Z. recommends the use of 1 to 1.5 parts of B_2O_3 in 100 parts of glass or about 2.5 to 4.0 kg. borax to 75 to 80 kg. of sand. L.T.B.

Expansion of soda-borosilicate glasses between 25°C and 150°C as a function of their chemical composition. R. WEINIG AND E. ZSCHIMMER. *Sprechsaal*, **62** [46], 855–57; [47], 874–78; [48], 889–91 (1929).—(1) Measurements were made with a dilatometer according to Leman-Werner-Gehlhoff (C. P. Goerz) of the coefficients of linear expansion between 25°C and 150°C of a number of batches of SiO_2–B_2O_3–Na_2O systems. The error amounted at most to ± 0.6%. The batches were prepared in a platinum crucible and they contained as much as 0.23% (Al_2O_3 + Fe_2O_3). The test rods were drawn or poured out of the batches, carefully cooled, and analyzed after measuring. (2) For the 3-substance system between 5% and 20% Na_2O and 5% and 20% B_2O_3, the "α" surface assumes the shape of a parabolic cylinder. Its equation is $\alpha.10^7 = 0.0588\ (B_2O_3 - 15) + 3.80\ (Na_2O - 5) + 33$ where B_2O_3 or Na_2O mean their corresponding variable percentages in the glass. The "α" values calculated from this deviate as much as ±2.0% from the observed measured values. (3) The equalized section curves of the actual "α" surface gave two tables for the average specific difference in action of soda and boric acid for every 5 or 6 fundamental glasses. The "α" values calculated with the specific difference in action, agree more closely than the values of the cylinder equation. This method of calculating should be the most suitable for practice. (4) In

addition, the linear expansion coefficient of chemically pure B_2O_3 was determined. It is as follows: between 25°C and 75°C 152.2 $\times 10^{-7}$ and between 75°C and 150°C 153.1 $\times 10^{-7}$. They agree very well with the values of Cousen and Turner published in 1928. (5) From a comparison table the "α" values given in the present work with the calculation from the cylinder equation show for the most part a satisfactory agreement with the expansion coefficients measured by S. English and W. E. S. Turner; similarly, the calculation from the specific differences in action and the calculations from the valid additive coefficients up to 12% B_2O_3 agree satisfactorily. In some cases the English measurements of the coefficients of expansion, calculated from the cylinder equation and from the specific differences in action, differ from 5 to 15% from the measured values. It can be confirmed that the additive coefficients of English and Turner (up to 12% B_2O_3) give, in general, satisfactory values; which fact makes clear that the parabola-shaped conducting curve of a cylindrical "α" surface approaches a straight line at some distance from the top of the parabola. M.V.K.

Coloration of glass by X-rays. C. W. Parmelee, G. L. Clark, and A. E. Badger. *Jour. Soc. Glass Tech.*, **13** [52], 279–85 (1929).—A discussion is given of the results obtained by a number of investigators on the effect of sunlight, radium, and Roentgen rays on the colors of various glasses. In order to ascertain the colors which would be produced in irradiated glasses by the presence of a small amount of impurities a series of tests was made on borax beads containing the elements or compounds to be investigated. The results are given in a table. The most pronounced changes were observed in the conversion of chromium green into a brownish-yellow color, of colorless lead to a brown stain, of colorless thallium to a very dark brown, of colorless bismuth to an orange-yellow, and of colorless manganese to a violet tint, the last two being the only pleasing hues produced. A few silicate glasses were radiated with no distinct alteration observable in the colors of these glasses consisting of selenium ruby, cobalt blue, iron amber, and copper-chromium green compositions. G.R.S.

Diffraction of X-rays by ordinary glass subjected to various treatments. C. W. Parmelee, G. L. Clark, and A. E. Badger. *Jour. Soc. Glass Tech.*, **13** [52], 285–90 (1929).—Particular attention was given to vitreous silica in this investigation, since it is the simplest glass, and also because of the importance of silicon dioxide in any glass study. The sample of glass to be studied was held in the loop of platinum wire supported in a platinum resistance furnace, so that the bead of glass was penetrated by an X-ray beam. The diffracted beam on emerging from the furnace registered on a photographic plate. The glass was photographed at 100° intervals from room temperature to 1300°. The plates showed broad diffuse rings characteristic of amorphous substances. Measurements of diameters of these rings indicated apparent interplanar distances of approximately 7.1 and 2.5 A.U. Silica seemed to be the building stone of glassy structures, because the broad rings were duplicated in cases of various silicate glasses studied. No sharp lines were produced by selenium ruby, copper ruby, or cryolite opal glasses similarly melted. Pyrex devitrified at about 800° produced lines of cristobalite. Diffuse rings seem to indicate inherent tendency of glasses to devitrify. Glass under stress was X-rayed but no fibering was noticeable. Similar tests on opal glass gave negative results showing that the method is unsuitable for detection of regularly distributed strains which are found in commercial enamels. G.R.S.

Crystal growth in opal glass—a correction. J. F. Hyslop. *Jour. Soc. Glass Tech.*, **13** [50], 129–30 (1929).—In an earlier paper it was deduced that the crystal particle size in opal glass, for equal times of heating under the critical point, is inversely proportional to the viscosity of glass. For equal times of heating at temperatures under the critical point the crystal size increases with temperature and with reduced viscosity of the glass. G.R.S.

Influence of grain size of batch materials in rate of melting. G. A. GREEN, F. W. HODKIN, M. PARKIN, AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **13** [49], 57–63 (1929).—Duplicate meltings were carried out at 1400°C in 56-lb. and 100-lb. pots. The sand was sifted, sizes larger than 30-mesh and smaller than 100-mesh being discarded. Three gradings were made, giving sizes between 30 to 50-, 50 to 70-, and 70 to 100-mesh. The comparison of different ratios of melting and properties of the resulting glasses are shown in a table. With decrease in size of sand grain the rate of melting increased, but the color of the resulting glass was less satisfactory. Batches with 30 to 100- and 70 to 100-mesh sand required 120 minutes for complete disappearance of batch. With increase in grain size of soda ash there was some slowing up in the rate of melting. Three sizes of limestone were tested. With ordinary size the batch melted down and was batch free in 4 hrs. With coarser limestone the melt was not batch free until after 7 hrs. Accompanying the slow melting rate there was a deterioration in the working properties of the glass. The best results were obtained with material which passed a 200-mesh sieve. The glasses had about the same compositions from different melts with various sizes of limestone. G.R.S.

Measurement of the viscosity of glass at high temperatures by the rotating cylinder viscometer. R. F. PROCTOR AND R. W. DOUGLAS. *Jour. Soc. Glass Tech.*, **13** [51], 194–213 (1929); for abstract see *Ceram. Abs.*, **8** [10], 716 (1929). G.R.S.

Observation of M. Le Chatelier's equation for viscosity of glass. F. W. PRESTON. *Jour. Soc. Glass Tech.*, **13** [49], 19–25 (1929).—P. objects to the double logarithmic formula devised by M. Le Chatelier in that it has an air of physical imcomprehensibility and of physical impossibility. In reply, M. Le Chatelier agrees with P. that the formula cannot express a physical law, and that he gave it only as an empirical formula. G.R.S.

Homogeneity of small-scale glass meltings in platinum. V. DIMBLEBY, H. W. HOWES, AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **13** [51], 243–48 (1929).—Modern research on the physical properties of glasses has in relatively few cases only been conducted on specimens having the homogeneity of optical glass or even of glass prepared by ordinary commercial methods on the large scale. Certain factors which add to the difficulty of preparing homogeneous melts in small crucibles are (1) the great surface area in proportion to the mass of glass, (2) more extensive corrosion, and (3) the difficulty of obtaining pourings or ordinary drawings of glass free from waves, cords, striae, and other sources of inhomogeneity. Impurities and inhomogeneity traceable to corrosion of the containing vessel are more pronounced the smaller the vessel. Experience has shown that sodium carbonate near its melting point attacks platinum 20% rhodium alloy more readily than it does pure platinum. Even in melting a simple glass containing 16% sodium oxide at 1350 to 1450°, the alloy is more soluble than is pure platinum. A glass obtained from a melting period of 20 hours at 1400° was stirred by hand for an hour before being worked out of the crucible. It was remelted and rods were drawn for physical testing. Chemical analysis showed that successive rods from the same crucible varied in composition. The results indicated (1) that in all small-scale glass meltings made in platinum or its alloys, the melt should be poured or otherwise worked out of the crucible, crushed, mixed, and remelted in a clean crucible, in order to obtain homogeneous glass; and the process repeated if analysis of the product fails to give assurance of homogeneity; (2) that to reduce contamination arising from the solution of platinum or rhodium, it is advantageous to sinter the batch in a silica crucible before the initial melting is carried out; (3) that stirring by hand at high temperatures is ineffectual in obtaining homogeneous glass in platinum crucibles; and (4) that the inhomogeneity observed could not be attributed to volatilization of alkali from the surface layers of the glass under the conditions of experiment described. G.R.S.

Test for detection of iron oxides in glass sands. J. T. RANDALL AND R. E. LEEDS. *Jour. Soc. Glass Tech.*, **13** [49], 15 (1929).—A sample of the sand is heated in a clay boat in an atmosphere of dry hydrogen at 1000°C for half an hour. The oxide is reduced to metallic iron and the change in color of the sand is easily seen. G.R.S.

X-ray investigation of feldspar glasses. G. L. CLARK AND C. R. AMBERG. *Jour. Soc. Glass Tech.*, **13** [52], 290–96 (1929).—The authors used the X-ray diffraction methods, which have been employed in many similar studies on long chain organic compounds to investigate the constitution and structure of feldspar glasses. The multiple General Electric apparatus was used for the monochromatic, pinhole method. Silica glass showed the molecule to be an elongated affair. Two bands were always obtained indicating that the molecules may be oriented in two directions. The molecules were arranged end to end separated by small gaps of 0.222 Å. The chains were grouped in small cybotactic bundles. Silica molecules in silica glass appear to be 6.928 Å. long and 2.52 Å. wide. The results obtained with soda feldspar glass indicated that it was a solution of sodium and aluminium oxide molecules in silica, the diffraction pattern of the latter being modified by the presence of these foreign molecules. This resulted in decreased spacings, with greater density than that of silica glass. With increase in temperature there was a decrease in volume followed by an increase approaching that of silica glass. G.R.S.

Influence of Al_2O_3 and SiO_2 on properties of glass. M. A. BESBORODOV. *Glashütte*, **60** [1], 5–9 (1930).—A study of a SiO_2, B_2O_3, Al_2O_3, CaO, Na_2O glass showed that (1) as the Al_2O_3 and SiO_2 were increased the rate of devitrification decreased; (2) resistance of such glasses to caustic soda increased as the SiO_2 was increased but decreased as the Al_2O_3 was increased; (3) resistance to Na_2CO_3 solutions increased as the SiO_2 and Al_2O_3 were increased; (4) resistance to H_2SO_4 was increased as SiO_2 was increased but decreased as the Al_2O_3 was increased; (5) resistance to water was increased as the SiO_2 and Al_2O_3 were increased. L.T.B.

Stones in glass. HUGO KÜHL. *Glashütte*, **59** [48], 880–81 (1929).—K. found that stones were formed in a certain glass because of poor grinding and mixing of the raw material. L.T.B.

Rarer elements in the glass industry. H. CONRAD MEYER. *Glass Ind.*, **11** [3], 63 (1930).—Cerium oxide is used in limited quantities in optical glass where it is desired to cut out ultra-violet rays, producing a bright yellow glass. Didymium oxide imparts amethystine and orchid shades, but must be of the highest purity and free from cerium and other elements of the same group. Iron chromite is being used on a large scale as a substitute for the more expensive chrome oxide and sodium chromate, imparting beautiful emerald green tints. Selenium has been used for many years in the production of ruby glass in conjunction with cadmium sulphide, but its most important use is as a decolorizer, being a component of most of the various decolorizing compounds now on the market. Titanium dioxide is principally used in fine table glassware, imparting what is known as a "watered yellow" color. It is not a strong color but gives beautiful effects. Uranium oxide produces a fluorescent greenish-yellow glass which has been popular for the last few years. Zirconium oxide is said to reduce the coefficient of expansion and toughen the glass, a desirable thing, particularly in the case of milk bottle glass where the breakage is high. E.J.V.

Data on the thermal stability of glass. M. A. BESBORODOV. *Ceramics and Glass* [Moscow], **5** [6], 208–11 (1929).—A definition of thermal stability of glass as a function of the physical properties of glass is given. Formulas are deduced. After the discussion of the influence of the uniformity of the thickness of walls upon the thermal stability of laboratory glassware and thermal stability of small glass bars as function of their diameters, B. draws the following conclusions: (1) thermal stability of a glass sample

is a function not only of its physical properties but also of its geometrical characteristics; (2) the highest thermal stability of glass is obtained not only by the proper selection of its chemical composition but also by the selection of its best geometric exponents; (3) the lack of sufficient experimental material makes the establishment in all cases of a strict dependence between the thermal stability and geometric properties (form, diameter, thickness of walls, etc.), impossible; (4) the testing of several kinds of laboratory glassware has proved that the thermal stability is a function of the non-uniformity of the thickness of the walls (all other conditions being equal); (5) based on the experiments with glass bars the conclusion must be drawn that with the increase of the diameter their thermal stability decreases; (6) the following practical conclusion for manufacturing purposes may be drawn from the tests: without changing the composition of glass the increase of thermal stability of glassware may be obtained by making their walls of uniform thickness; (7) by studying the thermal stability as a function of geometric properties, forms for any kind of glassware securing the highest thermal stability may be obtained. W.A.

Ruby glass. WILLY HACKER. *Chem.-Tech. Rundschau*, **44,** 1494 (1929).—Gold ruby glass may be produced from 100 kg. sand, 15 kg. red lead, 15 kg. borax, 8 kg. potash, 12 kg. saltpeter, 4 kg. tartar, 1 kg. As, 30 to 40 g. gold dissolved in aqua regia, and 200 g. tin dissolved in HCl. Any excess of metallic oxide is to be avoided as it is favorable to imperfect working of the melt and production of a sealing-wax luster of the glass. Directions are also given for the production of Cassius' purple and copper ruby glass. (*C.A.*)

Relation between density and refractive index of silicate glasses, with application to determination of imitation gem-stones. F. A. BANNISTER. *Mineralog. Mag.*, **21,** 136–54 (1929).—A graphical method for distinguishing between silicate glasses is described; see also *Ceram. Abs.*, **8** [6], 445 (1929). (*C.A.*)

Glass: cut and engraved. WALTER BUTTERWORTH. *Jour. Soc. Glass Tech.*, **13** [51], 183–94 (1929); for abstract see *Ceram. Abs.*, **8** [10], 722 (1929). G.R.S.

Coloring incandescent lamps on inner surface. A. F. LINDSTROM. *Chem. Met. Eng.*, **36** [7], 410–11 (1929).—A machine has been developed by Westinghouse Lamp Company whereby bulbs are colored on the inside by spraying on a colored paint-coating. Such lamps are particularly useful in electric signs since they are permanently colored and are immune to weather conditions. The lamps are easily cleaned and the color cannot be scraped or chipped off. G.R.S.

Making glass disk for 70-inch telescope reflector. A. N. FINN. *Ind. Eng. Chem.*, **21** [8], 744–50 (1929); for abstract see *Ceram. Abs.*, **8** [11], 799 (1929). R.G.M.

Large lens for air service. ANON. *Nat. Glass Budget*, **45** [42], 7 (1930).—A lens, specially made for the U. S. air service, weighs 45 lbs. and is said to be the largest camera "eye" ever ground in America. With the mounting, it measures 9 by 9 in. and has a focal length of 36 in. It will take pictures of entire cities at one exposure. E.P.R.

Plan 200-in. mirror. ELIHU THOMSON. *New York Times; Nat. Glass Budget*, **45** [45], 23 (1930).—The production of a quartz glass mirror 200 in. in diameter for use in a telescope is anticipated. E.P.R.

Glass research at Furdue University. ANON. *Glass Ind.*, **11** [3], 71 (1930).—Karl Lark-Horovitz with three assistants is at present investigating the conductivity of glass at high temperatures; adsorption of ions on the glass surface, especially in glasses of the Pyrex group; also electromotive forms of glass, especially colored glasses, both those containing ordinary metals like copper, iron, zinc, and also glasses containing rare earths such as neodymium, praseodymium, and lanthanum. Plans are also being made to investigate viscosity of glasses at high temperatures and to make

tests on glass, including its shatterability. Work is also being done in the making of X-ray photographs of refractories. E.J.V.

Simplified costs for glass plants. IV. D. D. LILLEY. *Ceram. Ind.*, **14** [3], 309–13 (1930).—Reference is made to a few ways of utilizing cost information which are not generally in use. In industry as a whole costs have been kept in the background, but progress is being made. For Part III see *Ceram. Abs.*, **9** [3], 237 (1930). F.P.H.

Glass as important building material. FRANK L. WRIGHT. *Brick Clay Rec.*, **76** [5], 314 (1930); see also *Ceram. Abs.*, **9** [4], 269 (1930). E.J.V.

Continuous process for plate glass at the Ford River Rouge plant. E. P. PARTRIDGE. *Ind. Eng. Chem.*, **21** [12], 1168–71 (1929).—The plant described contains four complete units, each of which can produce 16,000 sq. ft. of glass per day of 24 hours. The continuous process provides for the direct flow of molten glass from a tank furnace to rolls which flatten it into a continuous sheet which passes immediately into the leer. As the annealed glass leaves the leer it is cut into convenient lengths and is transferred directly to a continuous grinding and polishing operation. The finished pieces of plate glass from the polishing table are washed, inspected for defects, laid out for cutting, and cut to desired sizes, and the cut pieces pass on conveyers to the shipping room. Seven hours and a half after the melted glass flows from furnace to the rolls it is in the shipping room. The batch formula (in lbs.) is as follows: Ottawa sand 444, soda ash 140, limestone 128, salt cake 29.5, cullet 150, arsenic 2.7, charcoal 1.25. The tank furnaces are of the Siemens regenerative type. Each furnace has an output of 32 T. of glass per 24 hrs., and an average life of from 11 to 12 months. They are operated with temperatures of 2650°F in the melting end and of 2350°F in the refining end. Melted glass flows from the refining end through a 14-in. flux block channel to the rolls. The flow of glass is controlled by clay gates which are adjusted by the operator to maintain a constant width of 40 in. on the sheet of glass leaving the rolls. Less than a minute elapses from the moment the glass flows from the channel until it is entering the leer. Both rolls are cast iron and are water-cooled with thermostatic control. The larger roll is 4 ft. in diameter, the smaller 10 in. The latter is adjusted to produce a glass sheet of a thickness between 0.285 and 0.305 in., while the former is adjusted to a peripheral speed of approximately 40 in. per min. Owing to the necessity for straight-line flow, each of the four furnaces requires an individual leer. Each leer is of the muffle type, 442 ft. long, and is fired by gas with automatic-temperature control on the various sections. The temperature in the first section is 1100°F and is decreased 50°F in each succeeding section until a temperature of 650°F is reached. Following this it is decreased 100°F in each of the remaining sections, the glass leaving the leer ultimately at slightly above room temperature. Approximately 2 hrs. and 20 min. are required for the passage of the glass through the leer. The glass sheet is cut into 9-ft. lengths and passes to a series of 79 grinding and polishing wheels which are divided into three groups known as sand, garnet, and rouge laps. During annealing, grinding, and polishing the glass sheet travels approximately one quarter of a mile and the present layout economizes space in a very efficient manner. R.G.M.

Blue Ridge Glass Corp. products. ANON. *Amer. Glass Rev.*, **49** [20], 26 (1930).—This article presents some of the products of the Blue Ridge Glass Corp.; a smooth glass for building side-walls, partitions, and monitors. The patterned surface has hundreds of tiny lenses which transmit and transfuse light. "Industrex" glass has been developed especially for use in industrial buildings where all the light possible is required but without glare. For previous abstract see *Ceram. Abs.*, **8** [10], 724 (1929). E.P.R.

Forty years of glassmaking. ALDEN WELLES. *Crockery Glass Jour.*, **108** [1], 40 (1930).—Comparison of the earliest product of our foremost glassware factories with

the ware which they produce today brings to the impartial observer a grateful sense of progress and improvement. The Westmoreland factory was established in 1889, at Grapeville, Pa. Descriptions and comparisons of past and present products are given. E.P.R.

West-country glasshouses. F. BUCKLEY. *Jour. Soc. Glass Tech.*, **13** [50], 124–29 (1929).—An account is given of the early glasshouses from the time the first was established in Newnham (also the first in England) to the termination of glassmaking at Stanton Drew in 1825. The following locations are included in the discussion. Gloucester, Topsham, Odd Down, Bridgewater, and Stanton Drew. In an appendix there is a list of references. G.R.S.

Old Lancashire glasshouses. F. BUCKLEY. *Jour. Soc. Glass Tech.*, **13** [51], 229–42 (1929).—The history is traced of glassmaking in the 18th and 19th Centuries at Liverpool, Prescot, Warrington, and Manchester. G.R.S.

Austrian glass industry. HANS REIF. *Glashütte*, **60** [1], 9–10 (1930).—An economic review with a detailed description of the newly enlarged Stiassny plant near Salzburg. L.T.B.

Optical glass in Italy. LEONARDO MOSMIERI. *Giorn. chim. ind. applicata*, **11** [9], 417 (1929).—The Institute of Research for the Study and Application of the Products of Boron and Silicon located at Florence, Italy, was recently organized for the purpose of investigating and improving the conditions of this industry in Italy to enable it to compete with foreign production. It has the following program for research: Part I (*a*) definition and nature of glass, (*b*) chemical analysis of glass, (*c*) physical behavior of glasses with respect to their constituents, (*d*) study, definition, and function in glasses, of eutectic points relative to the physical combinations of the constituents of glass, (*e*) action and study of constituents of glass with regard to the coloring which they produce, (*f*) work on the thermal phenomena influencing the formation of glasses. Part II (*n*) study of the phases of concentration of the reciprocal physical combinations of the constituents of different batches of optical glass, (*o*) behavior and transformation of solid solutions existing in different optical glasses through energy effects, (*p*) study of the solid emulsions or colloidal states with respect to their molecular grouping, their formation, and questions relating to the inherent physical properties of optical glass, (*q*) study of Italian clays, (*r*) study of mechanical mixing, (*s*) study of the process of fusing different optical glasses, (*t*) study of the general technicalities of the optical glass industry and the policies to adopt. M.V.K.

Symposium on glass. K. SCHEEL, F. WECKERLE, AND A. WENDLER. *Glastech. Ber.*, **7** [1], 1–7 (1929).—A combined report of three committees of the German Society of Glass Technology is presented. There are committees on (1) the physics and chemistry of raw materials and glass, (2) heat economy, (3) refractory materials and tank construction, and (4) working glass by hand and machine. E.J.V.

New Boston skyscraper to be tower of ultra-violet light. ANON. *Nat. Glass Budget*, **45** [42], 11 (1930).—The United Shoe Machinery building, 24 stories high, will be a tower of living ultra-violet light. The terraced architecture of the massive structure making available the utmost of "skyshine" has been planned to obtain every benefit from it by the use of special windows of ultra-violet transmitting glass, which admits the health rays of the sun that are excluded by ordinary glass. Every window of the 290 ft. building will be of this special glass. E.P.R.

Glass houses a possibility. ANON. *Nat. Glass Budget*, **45** [43], 4 (1930).—Remarkable progress is being made in experimenting with glass brick. Such brick permit light but distort vision from the outside. Already a half dozen building fronts on Fifth Ave. are almost entirely of glass, both clear and opaque, up to the 2nd and 3rd floors. E.P.R.

Ultra-violet ray glass in bank. ANON. *Nat. Glass Budget*, **45** [44], 7 (1930).—There is a gradual increase in producing glass which will allow the transmission of a large percentage of the ultra-violet rays. A new building for a London bank will consist of a group of pavilions and terraces which will be lighted by overhead windows glazed with Vita glass. E.P.R.

PATENTS

Forming sheet glass. NICKLAS FRANZEN. U. S. 1,749,332, March 4, 1930. In a glass-melting and sheet-forming apparatus, in combination, a melting furnace, outports in the walls of the furnace below the normal levels of molten glass therein, a baffle in the path of flow of glass from the furnace to the ports having an open-end trough extending from a point on the side away from the port and below the normal levels of molten glass therein, an opening on the port side of the baffle at a point within the levels of molten glass in the furnace, a plurality of troughs communicating with the ports, a longitudinal funnel for receiving molten glass from the plurality of troughs and having its lower and outgoing opening of dimensions approximating the cross-sectional dimensions of the sheet glass to be made and forming means for receiving the stream of molten glass from the funnel.

Manufacture of glass sheets. LOUIS BOUDIN. U. S. 1,749,798, March 11, 1930. The combination with an intermittent sheet-glass forming machine, and with a leer to receive the sheet as formed, of at least five groups of rollers arranged along the length of the leer, means for driving the rollers of the first group at substantially the speed of sheet formation, means for engaging and disengaging rollers of the second group with and from the drive of the first group, means for driving the rollers of the fifth group at a substantially constant speed, and means for engaging and disengaging the rollers of the fourth group with and from the drive of the rollers of the fifth group, the rollers of the third group being idlers.

Sheet-making apparatus. ARTHUR R. MCARTHUR. U. S. 1,750,534, March 11, 1930. The combination with a sheet hot mill, of a continuous heating furnace for supplying heated sheets to the mill, a conveying table for receiving the heated sheets from the furnaces, an automatic mechanical feeding table for feeding the sheets into the bite of the hot mill rolls, the feeding table including a plurality of power operated conveying rollers inclined downwardly toward the mill so as to feed the sheets by combined gravity and power, and side guides on the feeding table for guiding the hot sheets squarely into the mill, the guides being adjustable for various sizes of sheets, and an automatic mechanical catcher on the exit side of the mill for catching and gaging the rolled sheets, the catcher being adapted to return all sheets under a predetermined gage to the feeding table for rerolling.

Automatic temperature control for glass. JOHN F. RULE. U. S. 1,750,966, March 18, 1930. (1) A glass feeder comprising in combination, means for flowing and suspending charges of molten glass, means for severing the charges periodically, individual mechanisms for applying cooling and heating mediums to the molten glass prior to its suspension in charge form, a control bar pivoted to the severing means, a portion of the control bar movable into and out of the path of travel of severed charges in synchronism with movements of the charge severing means, the control bar being adapted for rocking upon its pivot under influence of suspended charges of abnormal length, and means whereby movement of the control bar will cause application of the heating or cooling medium to the glass prior to its formation into charges and thereby control the length of succeeding charges. (2) Method of maintaining uniformity in the volume of gathers of glass produced by an automatic glass feeder, which consists in causing a gather of glass as it issues from the feeder to regulate the amount of glass in a suc-

ceeding gather in response to a departure of the issuing gather from a predetermined normal volume. (3) Combination of a container for molten glass, means for causing a regulated discharge of glass therefrom, a temperature controlling device in the path of and actuated by the issuing glass, and means controlled by the device for automatically regulating the temperature of the glass in the container. (4) Apparatus for delivering charges of molten glass comprising a container from which the glass issues, means for separating the charges from the supply body of glass in the container, means for directing a flow of temperature regulating fluid, and automatic means controlled by the condition of the glass for regulating the flow of the fluid, the means comprising a mechanical element contacting with the glass before the separation and moved thereby to a position determined by the condition of the glass.

Automatically controlling temperature of molten glass. JOHN F. RULE. U. S. 1,750,967, March 18, 1930. Means for controlling the temperature of molten glass, comprising a mechanical element in contact with the glass, means for moving the element, and means governed by the resistance of the glass to the movement of the element for controlling the application to the glass of a temperature regulating medium.

Producing tubular glass. LEONARD D. SOUBIER. U. S. 1,750,971, March 18, 1930. Combination of a container for molten glass having a bottom outlet opening in the floor thereof, a stationary mandrel projecting downwardly into the opening and forming therewith an annular passageway through which the glass issues, a stirring tube surrounding the mandrel and projecting downward into the glass into proximity to the floor of the container to provide an annular passageway through which the glass flows from the supply body to the outlet, and mechanism for continuously rotating the tube.

Forming glass tubing. LEONARD D. SOUBIER. U. S. 1,750,972, March 18, 1930. In a tube forming apparatus, the combination of a container for molten glass having an outlet opening extending through the floor thereof, means for supplying molten glass to the container and maintaining a head of glass therein, a mandrel comprising a stem projecting downward into the glass in the container and a head carried by the stem and projecting into the outlet opening, means for supplying air through the head, a tube surrounding the stem and projecting downward into the glass with its lower end terminating at a level above the floor of the container, and means for continuously rotating the tube and container.

Glass feeder. LEONARD D. SOUBIER. U. S. 1,750,973, March 18, 1930. A glass feeder comprising in combination, a container for a moving body of molten glass, a burner supplying heat to the glass, a valve regulating the supply of fuel to the burner, a pair of solenoids operable independently of each other to actuate the valve and increase or decrease the flow of fuel therethrough, a circuit closer operable to cause energization of either solenoid, and a finger carried by the circuit closer and projecting into the moving body of molten glass, the finger being movable by the molten glass in response to changes in the viscosity of the glass to actuate the circuit closer and thereby energize one of the solenoids.

Glass-feeding apparatus. ENOCH T. FERNGREN. U. S. 1,750,998, March 18, 1930. Glass-feeding apparatus comprising in combination, a container for molten glass having an inner outlet orifice surrounded by an annular outlet orifice, a regulating rod projecting downward through the inner orifice, and means to reciprocate the rod vertically, the portion of the rod which works in the orifice being tapered and thereby operative to vary the open area of the inner orifice.

Glass tank. LEOPOLD MAMBOURG. U. S. 1,751,045, March 18, 1930. In glass apparatus, a furnace containing a mass of molten glass, a cooling chamber associated therewith for receiving the molten glass therefrom, a jack-arch arranged at substantially the juncture of the furnace and cooling chamber and having its lower end dipped down-

wardly into the molten glass to allow sub-surface glass only to flow from the furnace into the cooling chamber, a working receptacle associated with the cooling chamber for receiving the molten glass therefrom, a jack-arch arranged at substantially the juncture of the working receptacle and cooling chamber and having its lower end dipped downwardly into the molten glass to allow sub-surface glass only to flow from the cooling chamber into the working receptacle, and trough means associated with the jack-arches for catching the upper stratum of glass retarded thereby and directing the same toward the opposite sides of the furnace and cooling chamber, respectively.

Making laminated glass. WILLIAM E. NOBBE. U. S. 1,751,051, March 18, 1930. Method of producing laminated glass, which consists in interposing a plurality of individual sheets of nonbrittle material between two relatively larger sheets of glass, arranging the sheets of nonbrittle material side by side so that their outer edges will be flush with the edges of the glass sheets and their adjacent edges in abutting or substantially abutting relation, uniting the glass sheets with the individual sheets of nonbrittle material simultaneously, and in then cutting the glass sheets between the adjacent sheets of nonbrittle material.

Making laminated glass. WILLIAM E. NOBBE. U. S. 1,751,052, March 18, 1930. Method of making laminated glass, which consists in interposing a plurality of individual sheets of nonbrittle material between two relatively larger sheets of glass, arranging the sheets of nonbrittle material side by side with their edges in spaced relation, uniting the glass sheets with the individual sheets of nonbrittle material simultaneously, and in then cutting the glass sheets intermediate the adjacent edges of the sheets of nonbrittle material whereby each individual cut sheet will have a peripheral groove or recess.

Cerium and manganese dioxides for decolorizing. WILLIAM CHITTENDEN TAYLOR. *Glass Ind.*, **11** [3], 70 (1930).—A detailed account of U. S. Patent No. 1,726,635, covering the use of cerium dioxide with manganese dioxide for decolorizing glass, and eight claims on the process of decolorizing and of intensifying the decolorizing effect of manganese dioxide is given. See also *Ceram. Abs.*, **8** [11], 804 (1929). E.J.V.

Compound glass. H. D. MURRAY AND D. A. SPENCER. Brit. 323,301, Feb. 19, 1930. To insure adhesion between glass and celluloid in the manufacture of safety glass, the elements are mounted in the presence of an emulsion of two substantially immiscible liquids, one being a solvating agent for the celluloid and the other being a solvating agent of the substrata, *e.g.*, gelatine. Examples of such emulsions are 40 parts by vol. of amyl alcohol and 60 parts by vol. of an aqueous solution containing 1% gelatine and 7% of glacial acetic acid or 100 parts by vol. of amyl acetate to which has been added about 0.1% of iodine with 100 parts by vol. of water. In the latter case the gelatin coatings should be prepared from a gelatine sol containing a deodorizer such as 0.5% of sodium thiosulphate. See *Ceram. Abs.*, **7** [2], 76 (1928).

Controlling air supply in glass manufacture. T. F. PEARSON. Brit. 323,422, Feb. 19, 1930. A timing device for controlling the supply of air to the different operating parts of an automatic glassworking machine comprises a rotating sleeve valve adapted to control the flow of air through ports in a cylinder, and a number of masking sleeves which are arranged between the rotary sleeve and the cylinder and can be displaced angularly in order to vary the phase relationship between the passage of air through the different ports. A worm secured to a driving shaft rotates the sleeve valve which is contained within, and is coaxial with a cylinder. The sleeve valve has an axial bore that forms a passage leading to a main exhaust port, and also has a number of radial passages that communicate with pipe connections fitted in the wall of the cylinder. The valve also has a longitudinal passage in permanent connection with an air inlet to the cylinder. Radial passages lead from the passage to the pipe connections. A number

of sleeves, each having a peripheral groove and a radial passage therein, fit over the sleeve valve and fill the space between it and the cylinder. Each of the sleeves is formed with worm teeth which gear with a worm on a control spindle. These spindles are provided with hand wheels, and by turning any individual sleeve, the radial passage in it will be displaced relatively to the corresponding radial passage in the valve. Thus the time of operation of a pneumatic device connected with any of the pipes can be altered as desired.

Splinterless glass. M. A. COLEFAX. Brit. 323,671, Feb. 26, 1930. A splinterless glass which is permeable to ultra-violet rays comprises a sheet of cellulose acetate arranged between sheets of the glass sold commercially under the registered trade mark "Vita," or other glass which transmits ultra-violet rays.

Cooling sheets of compound glass. G. B. RILEY. Brit. 323,727, March 5, 1930. Plates or sheets of compound or reinforced glass or of other material are cooled after heat treatment by conveying them through a cooling chamber on a conveyer belt on which a cooling medium is spread. An endless belt of fabric or other absorbent material is deflected through a bath of liquid, preferably cooled continuously by refrigerating pipes, and its upper stretch passes over a supporting conveyer belt. The plates, etc., are delivered onto the belt by a conveyer and may be discharged by similar means.

Compound transparent sheets. E. BURNET. Brit. 323,745, March 5, 1930. Sheets of glass are united during the setting of a suitable cement applied thereto by a press provided with a pneumatic cushion, air being admitted to the piston. The pressing operation takes place in a box on a wood base, the box being exhausted. The platen of the press is provided with a rubber cushion by which the edges of the compound sheets are clamped before air is admitted for the final pressing. The sheets may be supported with suitable cement applied thereto on stepped supports on which they are pressed.

Compound transparent sheets. E. BURNET. Brit. 323,783, March 5, 1930. Curved compound transparent sheets are formed by uniting thin flexible sheets of glass and cement by pressure on a curved base, with or without stepped supports for the separate sheets. The sheets when placed on the container are subjected to a vacuum, the press with pneumatic cushion is then forced onto the sheets by means of a piston and air admitted by opening cock. Air, heated if desired, is then admitted, the cock being closed, and after setting of the cement the compound sheet is removed. The press is preferably provided with a rubber cushion to engage the edges of the sheets and to prevent entry of air when the pressure in the container is restored to atmospheric.

Apparatus for delivering molten glass. WM. J. MILLER, INC. Fr. 667,140, Dec. 5, 1928. (*C.A.*)

Reënforced glass. DU PONT VISCOLOID CO. Fr. 667,852, Jan. 21, 1929. The sheet of plastic material between 2 sheets of glass is not given a previous polishing, but the 3 are submitted to heat (100 to 115°) and compression (10 to 35 atm.) sufficient to obtain the union of the elements between themselves and at the same time to polish the sheet of plastic material between the sheets of glass. (*C.A.*)

Compound glass sheets. LOUIS BARTELSTONE. Fr. 666,395 and 666,396, Dec. 26, 1928. The construction of compound sheets containing 2 sheets of glass, a sheet of celluloid, etc., and transparent films of a compound of cellulose free from camphor is described, the films being in direct contact with the inner surfaces of the glass. Fr. 666,397 describes a compound sheet which is resistant to weather, the inner organic sheet having its edges recessed, and the groove formed being filled with a resistant material. (*C.A.*)

Apparatus for making massive glass objects by pressing between rolls. RUDOLF BERGMANN AND RICHARD FUNKE. Ger. 484,280, Nov. 19, 1927. (*C.A.*)

Machine for rolling glass plates. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOIT VAN OCTROOIEN. Ger. 484,281, May 19, 1928. (*C.A.*)

Double-walled glass vessels. THERMOS A.-G. Ger. 484,283, Jan. 17, 1928. Details of manufacture are given. (*C.A.*)

Colored glass. ALBERT STAHL. Ger. 485,910, Jan. 5, 1928. A method of preparing multi-colored glass consists in enclosing a layer of colored glass between two transparent layers, cutting as required, re-heating, and shaping. (*C.A.*)

Heavy Clay Products

Influence of $CaSO_4$ on brick. ANON. *Corriere ceram.*, **10** [6], 219–21 (1929).—Among the methods of eliminating gypsum from brick to prevent efflorescence are the following: (1) addition of baryta, (2) rapid drying, (3) firing to 800°C or 900°C which transforms gypsum into calcium oxide and SO_3. The application and results of these methods are discussed. M.V.K.

Improved clay building unit. ANON. *Arch. Rec.*, **67** [3], 289–90 (1930).—Report of the work of Geo. A. Bole, H. D. Foster, and others at the Eng. Expt. Sta. of Ohio State Univ. for the Structural Clay Tile Assn. upon a new light-weight efficient wall material at low cost. The new product is an aerated clay having an average weight of 30 or 32 lbs. per cu. ft., about $^1/_4$ brick weight. Compressive strength at this weight will be from 500 to 1000 lbs. per sq. in. depending on clay and degree of firing. An advantage of this material aside from insulating, and fire and sound proofing, is that it can be made in large slabs to be used wall-board wise with various joints. For interiors it may be natural, plastered, or glazed. It may be given salt glaze in manufacture at almost no added cost or a slip glaze of one or more colors. Subjected to standard fire test it shows in 80 min. the same rise in temperature that partition tile of the same thickness shows in 34 min. It is safe for fireplace construction and will no doubt find use as a furnace lining. It may be raised to 2000°F and quenched in water without damage. It fires with practically no warping and with shrinkage of only 3 to 5% from green to dry. Large units may be fired and then sawed (more easily than soft wood) or run through woodworking machines, refiring afterwards if desired. The estimated cost is about 2¢ a board-ft., but a saving will be effected through cancelling the necessity of measures such as fireproofing, etc. E.B.H.

New brick texture. H. M. FENATI. *Brick Clay Rec.*, **76** [4], 268 (1930).—A process and machine for putting a circular texture on a moving column of clay has been perfected. The scoring of the column appears in segments of a circle, the arc being of a different diameter on the head ends from that on the face, and each cut brick shows exactly the same number of segments in the same position. In order to produce this effect, the texture machine must revolve in ratio with the varying speed of the column and the texture must be so applied that when the column comes to the cutter, the segments must be in exact position with the cutting wires to produce uniform arcs on each brick. Illustrated. E.J.V.

Improving vitrified brick. ANON. *Brit. Clayworker*, **38** [454], 409–10 (1930).—The quality of vitrified brick usually depends chiefly on the raw materials used and on the skill with which the brick have been fired. Most vitrified brick are made from clays or shales fairly rich in iron oxide though there are some notable exceptions. The effect of the addition of iron oxide and manganese oxide to clay is discussed. Notes are given on work recently done by Hirsch relative to the addition of 10% fluxes to clays, the effect of adding a marl to a ferruginous clay, and the refractoriness of clinker brick under load. R.A.H.

Hollow tile manufacture and its difficulties. E. WINKLER. *Ziegelwelt*, **60**, 621–25, 639–41 (1929). (*C.A.*)

Properties of clays. KRAZE. *Ziegelwelt*, **60**, 815–18 (1929).—The general characteristics of clays are discussed from the viewpoint of the manufacturer of brick. (*C.A.*)

Preparation of clays. FRITZ LIEBELT. *Ziegelwelt*, **60**, 818–20(1929); for abstract see *Ceram. Abs.*, **9** [4], 276 (1930). (*C.A.*)

Brick made from stone mill waste. ANON. *Pit and Quarry*, **19** [8], 85 (1930).—Making building brick out of waste stone is a process invented by J. B. Newsom of Bloomington, an invention that probably will save much of the waste stone from mills and quarries and lower the cost of stone house facing from 15 to 20%. E.P.R.

Status of brick market. HUGO FILIPPI. *Brick Clay Rec.*, **76** [5], 312–14 (1930); *Clay-Worker*, **93** [3], 190–92 (1930).—Making an analysis of the more immediate past and the several influences which have brought about existing conditions, F. states there there were two primary causes responsible for the effect on the production and use of common brick. The first was the influence of engineering progress, and the second had to do with the failure of the industry to keep abreast of the specific requirements demanded by the changing times. Five specific reasons applying to each of the two causes are outlined. From a merchandising standpoint, there are two avenues open for future increase in the sale of brick: (1) that of reclaiming the lost markets and (2) creating new markets. The value of lectures in strengthening present markets and creating new markets for brick is stressed Twelve fundamental principles are laid down as a creed for the industry to study. E.J.V.

Chicago Tribune **raps clay products.** ANON. *Brick Clay Rec.*, **76** [2], 117 (1930).—Attention is called to the fact that the *Chicago Tribune* is consistently carrying on propaganda against clay products, especially brick. The clay products industry should know, for its own protection, that this paper is openly hostile and inimical in its news and editorial column. Some causes illustrating this point are cited. See following abstract. E.J.V.

Paving brick presents itself to the *Chicago Tribune*. ANON. *Brick Clay Rec.*, **76** [4], 248–49 (1930).—A thousand-mile inspection trip over Illinois highways in the interest of the Illinois paving brick industry to counteract the sentiments contained in an editorial antagonistic to paving brick recently published in the *Chicago Tribune* is described. The report of the automobile editor of the paper is reprinted. Illustrated. E.J.V.

Clay products for aviation plants. G. K. SPENCER. *Brick Clay Rec.*, **76** [4], 250–51 (1930).—In a recent air tour of the principal factories in North America, S. found almost universal preference for brick in construction. The greatest names in American aircraft construction have allied themselves with brick construction and 80% of new construction is either completely or partially of brick. Illustrated. E.J.V.

Modernization and remodeling movement. C. F. MATTES. *Clay-Worker*, **93** [3], 181–83 (1930).—Some interesting details are given about brick-veneering old buildings. E.J.V.

Trend of brick industry. P. O. DEITSCH. *Brick Clay Rec.*, **76** [4], 253–56 (1930); *Clay-Worker*, **93** [3], 186–88 (1930).—There are three roads possible for the brick industry to follow: (1) greater coördination, coöperation, and faith in the industry; (2) willingness either to lead or to be led, meaning a willingness to contribute, through honest suggestion, to the program which it is felt that the Common Brick Mfrs. Assn. should undertake in behalf of the industry, or a willingness to follow the lead established by fellow manufacturers in adopting the policies vitally needed; (3) the perpetuation

of the unprofitable dog-eat-dog attitude. These various points are discussed at length. E.J.V.

New process for using slag. ANON. *Engineer* [London], 147–478 (Nov., 1929); *Pit and Quarry*, **19** [10], 87 (1930).—Utilization of blast-furnace slag as road material is expected to be greatly stimulated by a new process developed by Bolckow, Vaughan & Co., Ltd., Middlesbrough, in which the molten slag is converted directly into road materials, eliminating the cost of dumping, and subsequent working. Slag from the basic blast furnaces is run into ladles which take it to casting pans alongside the furnaces, where it is cast into large cakes about 15 in. thick. While cooling, the slag anneals itself and a material almost as hard as granite and impervious to water is secured. The slabs, when cool, are broken and crushed, screened, and graded ready for delivery to the user. E.P.R.

Speedtile. ANON. *Brick Clay Rec.*, **76** [5], 315 (1930).—A tile with a handle known as speedtile, is a product of the Wheeler Building Tile Co., Inc., Fort Myers, Fla., which will insure speedier laying and a better wall. The weight of the unit is less than that of any other tile of like size and load-bearing quality. The handle feature on the tile saves in labor and time in setting up. Illustrated. E.J.V.

Silicate brick vs. clay products. ANON. *Brick Clay Rec.*, **76** [5], 336 (1930).—Silicate brick are manufactured from silicates and lime and sand, and are said to be much less moisture absorbent than the ordinary fired-clay brick. The components are ground together with the proper amount of moisture, pressed into brick, and cured in cylinders, under steam pressure of 110 lbs. for a period of 10 hours. This curing process causes a chemical reaction which practically transforms the brick into manufactured stone. This new product is made at the Paul Brick Co. plant, Phoenix, Ariz. E.J.V.

Modern sand-lime brick plant at Mishawaka, Ind. ANON. *Pit and Quarry*, **19** [8], 61–65 (1930).—The Northern Indiana Brick Co. of Mishawaka, Ind., uses most up-to-date equipment and has a capacity of 30,000 bricks per day. E.P.R.

BOOK

Drain Tile Manufactured in Ohio. J. OTIS EVERHART. O. S. U. Engr. Expt. Sta., 85 pp., 66 tables, 19 illustrations. Reviewed in *Brick Clay Rec.*, **76** [4], 273 (1930).—A history of the use of drain tile going back as far as the Middle Ages is given, followed with an exposition of early manufacture of tile in Ohio, and an outline of the distribution of tile plants in Ohio. The remainder of the book includes a short résumé of manufacturing methods and a considerable section on the developments of test methods, details of testing and information obtained, and methods of factory control testing. E.J.V.

PATENTS

Treating masonry surfaces. LOUIS S. WERTZ. U. S. 1,726,600, Sept. 3, 1929. Process of waterproofing masonry surfaces which consists in forcibly projecting into the masonry voids by compressed air, finely-divided particles of iron mixed with water and sal-ammoniac.

Fire wall. MICHAEL LIPTAK. U. S. 1,750,532, March 11, 1930. A permanent wall and a replaceable wall spaced therefrom, headers extending into both walls and across the space between them, and elements as part of the permanent wall arranged below the first-mentioned headers as supports and extending into the space between the walls, but not into the replaceable wall.

Porous materials. I. G. FARBENIND. A.-G. Fr. 667,821, Jan. 21, 1929. Light brick are made by mixing or beating binding clays with water and substances, which modify the surface tension of water, such as alkylated aromatic sulphonic acids, so as

to obtain a foamy mass, then adding stabilizing substances such as cement, feeble acids or feeble alkaline agents, drying and baking. (*C.A.*)

Slag brick. NAKAMURA. Fr. 620,456; *Refrac. Jour.*, **5** [53], 196 (1930).—Slags from copper refinery processes are molded into brick shapes and while still hot are sprinkled with a mixture consisting of powdered iron, mica, sulphur, and straw. The final cooling is carried out under a layer of ashes in order to prevent oxidation of the covering materials. E.P.R.

Ceramic building material. H. A. GRÖNROOS. Swed. 67,215, April 16, 1929. Plastic clay is mixed with an approximately equal amount of a fine-grained ignited material to obtain a mixture of granular consistency. This is rolled, crushed, and mixed with water in a stirring apparatus. The resulting finely divided mixture is formed into pieces by dry pressing, furnace-dried, fired, and cooled in a continuous process. (*C.A.*)

Porous clay brick. E. I. LINDMAN. Swed. 67,618, July 2, 1929. An addition to Swed. 66,109. The formed pieces before firing are provided with cavities between or surrounding which the material has a thickness of not more than 7 cm. (*C.A.*)

Brick. S. HELLSTRÖM. Swed. 64,608, Feb. 14, 1928. A suitable clay is heated to 300 to 900° to drive out the water of crystallization and to decompose the clay substance. The heating is stopped while 20 to 60% of the plastic clay substance remains to bind the mass, which is afterwards ground, moistened with water, pressed to brick, and fired without drying. (*C.A.*)

Brick. J. O. ROHDIN. Swed. 65,024, April 17, 1928. Clay is heated to 300 to 550°. The resulting product, after disintegration, if necessary, is classified according to particle size. Brick made from this material are fired without previous drying. (*C.A.*)

Porous brick. I. SETTERBERG. Swed. 66,251, Oct. 23, 1928. Finely ground refractory materials such as fire clay, chamotte, kaolin, quartz, quartzite, flint, magnesite, dolomite, Cr ore, alundum, etc., are made up with water to a plastic mass with addition of Al powder or other gas-forming substance, which is intimately and uniformly mixed into the mass. After gas evolution has ceased the mass is formed to bricks or blocks, dried, and fired at a high temperature. (*C.A.*)

Refractories

Refractories and refractory cements for nonferrous foundry. HAROLD E. WHITE. *Jour. Amer. Ceram. Soc.*, **13** [4], 219–41 (1930); for abstract see *Ceram. Abs.*, **9** [3], 191 (1930).

New chromite cement developed. ANON. *Brick Clay Rec.*, **76** [5], 332 (1930); *Pit and Quarry*, **19** [9], 71 (1930).—Adachrome Plastic Supercement, developed by Botfield Refractories Co., Philadelphia, Pa., is basically composed of an exceptionally high-grade chromite ore obtained from South African deposits, making it chemically inert, and also hard, dense, and highly refractory. The new cement employs a bonding agent which is efficient at high temperatures. A feature of the new cement is its exceptional plasticity, which contributes to ease of handling and working. The material is recommended for laying up fireclay brick, silica brick, chrome brick, high alumina brick, and also magnesite brick under certain conditions. It is also adaptable for use as a surface coating material, and as a binder in mixing patching materials for repairing burned-out sections of refractory construction. E.J.V.

Causes and prevention of bulging in hand-molded refractory shapes. GORDON B. RICHARDSON. *Jour. Amer. Ceram. Soc.*, **13** [4], 256–71 (1930).—Bulging is a universal problem in the manufacture of large refractory shapes. It is discussed from the

standpoint of molding, pressing, turning from the mold, drying, edging, firing, and air and gas pockets.

Forming pressure of dry-pressed refractories. I. Effect of pressure variations on properties of green and dry bodies. RAYMOND E. BIRCH. *Jour. Amer. Ceram. Soc.*, **13** [4], 242–55 (1930); for abstract see *Ceram. Abs.*, **9** [3], 192 (1930).

Classes and uses of fire clays. ANON. *Pit and Quarry*, **19** [11], 38 (1930).—Fire clays are clays that withstand high temperatures and usually are not fusible below about 3000°F. The term is used loosely, and almost all plastic clays found below coal seams are likely to be called fire clay. In an effort to bring order out of this chaos, the A.S.T.M. distinguishes as follows: (1) high-heat duty fire brick (divided according to composition into clay fire brick and siliceous-clay fire brick, of which the former has a higher P.C.E.); (2) intermediate-heat duty brick (cone 28); (3) moderate-heat duty brick (cone 26); and (4) low-heat duty brick (cone 19). The main use for fire clays is for the manufacture of the different shapes of fire brick, but they are also used either alone or mixed with other clays in refractory cements, gas or zinc retorts, furnaces or locomotive linings, crucibles, coke-oven brick, saggers, and other refractory products, and in addition considerable quantities are used in the production of floor tile and sanitary ware, stoneware, terra cotta, conduits, pressed and paving brick, Portland cement, plaster, etc. The most important domestic sources are formations of Carboniferous age in Ohio, Pa., Ky., Ind., Ill., Md., W. Va., and Mo., but fire clays are found also in Cretaceous and Tertiary beds in various parts of the country. E.P.R.

Method of testing probable durability of tank blocks. E. J. C. BOWMAKER. *Jour. Soc. Glass Tech.*, **13** [50], 130–40 (1929).—The present output of glass tank furnaces is now largely governed by tank block considerations alone. To determine the durability of a block a qualitative test was made by heating a chip of the block in a platinum crucible with a 2 to 1 HF–H_2SO_4 mixture. When all the HF was evaporated the chip was suspended by a fine platinum wire in a dilute (1 : 1) boiling H_2SO_4 solution to remove the film on its surface. Boiling water removed the excess acid and the chip was dried at 110°C. A good block shows crystalline matrix clearly after this treatment. The grog was held firmly with no gaps where grog was lost during the boiling. Little change except deep etching should appear. With a definitely bad block, no crystalline appearance was visible, the surface of bonding clay being smooth. Pits indicated lost grog. The whole appearance was ragged. Intermediate quality had the appearance of a combination of the two descriptions above. Samples kept made a valuable set of standards for comparison of new blocks. For quantitative results the test pieces, 1 by $^1/_2$ by $^1/_2$ inch (edges beveled) were dried at 110° for 4 hours. They were immersed in an acid mixture (3 parts by vol. of 50 to 60% HF to 2 parts concentrated H_2SO_4) contained in a lead distilling apparatus provided with a tightly fitting condenser cover. After heating for 3 hours the surface film was cleaned by boiling in dilute (1 : 1) H_2SO_4 for 1 hour, then in boiling water for 15 min. They were placed in a platinum crucible and dried at 110° to constant weight. The per cent loss in weight indicated the corrosion to be expected in the tank. This was found to be in accord with tank performance. Porosity and composition alone are insufficient as a basis of comparison. G.R.S.

Distribution of temperature and block corrosion in glass tank furnaces. F. F. S. BRYSON. *Jour. Soc. Glass Tech.*, **13** [50], 140–66 (1929).—Results are given on the rate of corrosion of blocks in different positions in the tank and exposed to different conditions of glass or in regard to temperature and movements of glass or semimolten batch. The method used was to determine temperatures close to the inner surfaces of the tank blocks in different parts of the furnace. Thermocouples were inserted in holes drilled to known depths in the blocks. There was thus obtained a measurement

of the differences in temperature of the interior of blocks in various parts of the furnace and also the change in temperature of a point within a block at various intervals of time. The time rate of temperature increase of the thermocouples gave a measurement of the corrosion rate of the block, provided the tank temperatures were not materially altered throughout the observation period. Records kept over the entire life of the furnace showed the following results: (1) The use of air for cooling the outer surfaces of the blocks resulted in an appreciable lowering of the temperature of these surfaces and also of the inner surfaces. There was no evidence that such cooling produced a layer of chilled glass on the inner surface even when the block was only 4 inches thick. (2) The temperature of the glass in contact with the top blocks was sufficiently high to render the glass mobile and to permit convection and other currents being set up close to the surface of the blocks. These currents might cause erosion of the blocks in addition to aiding solution. The nature of the corrosion of the blocks near the bridge was different from that near the doghouse, the difference being due to the different movement of the glass in the two positions. (3) Considerable variations were found to exist in the temperature of the glass from day to day, due to variations in the amount of glass being drawn off. (4) The rate of corrosion of the tank blocks near the surface of the glass was extremely rapid in the early stages. Near the middle of the furnace 1 inch of block was removed from the inner surface within 3 weeks after melting had commenced, about 2 in. within 10 weeks, and about 4 in. before the end of the fifth month. (5) On a horizontal level about 10 in. below the surface the rate of corrosion was not so rapid, amounting to about 1 in. in 10 weeks. (6) At a distance of about 16 in. from the surface the rate of corrosion was slow, less than 1 in. being removed during the whole life of the tank (7 months). (7) Near the glass level the block attack was most severe about 7 ft. from the bridge. The blocks near the doghouse underwent rapid attack during the first three weeks, but thereafter the rate of attack was slower than in other parts of the furnace. (8) The temperature of the glass near the surface was highest about midway between the doghouse and the bridge. Near the bottom of the tank the temperature of the glass was highest toward the bridge end. The temperature gradient within the glass from the surface to the bottom of the tank was greatest near the doghouse, diminishing rapidly to a point about 9 ft. from the doghouse, and gradually thereafter toward the bridge. The doghouse end of the furnace in this case was well exposed and consequently experienced a certain amount of cooling by the atmosphere. (9) Near the melting end a time-lag of about 20 minutes occurred before a change of temperature in the glass close to the wall 4 in. below the surface was recorded at a point 16 in. below the surface in the same vertical plane. The lag was greater near the middle of the tank close to the wall, but it was not measureable near the bridge where there was more rapid circulation of the glass. (10) Pt Pt-Rh thermocouples, when inserted through the tank blocks so as to be protected from the atmosphere of the tank, provide a method of measuring the actual temperature of the glass and so enabling control of temperature to be obtained. For the use over long periods, such thermocouples should be inserted in positions when the corrosion of the block is not rapid. G.R.S.

Stamping and mending methods for glass-melting furnaces. ANON. *Sprechsaal*, **62** [52], 966–67 (1929).—The stamping of the furnace bed is especially important. To obtain good results, wet or dry, attention must be paid to the composition of the mass, its mixing, the moisture (for the wet method), and stamping. Since the raw refractory clay added as a binder shrinks on firing, silica which expands must be added to counterbalance. Practice showed that rich stamp masses gave as good results as thin masses. Furnaces may be repaired (1) by using the mending mass, which is plastic and is capable of being pugged for large holes and cracks; (2) by a slip to fill small holes

and cracks; or (3) by a dry clay mixture. A greater cohesion of these masses with the kiln surface may be obtained by adding a certain per cent of powdered glass. M.V.K.

Most advantageous measurements of brick for stoves of glass furnaces. JULIUS LAMORT. *Glashütte*, **59** [46], 837–40 (1929).—A table is given which shows the relation of the thickness of the brick to the surface exposed together with the size of the chimney of the lattice work of stones for most efficient operation. L.T.B.

Temperature distribution and heat stored in brickwork of furnaces using powdered coal. RUMMEL KUHO AND OELLERS. *Arch. Wärmewirt.*, Feb., 1929. A.J.M.

X-ray study of zonal structure of silica brick from roof of a basic open-hearth furnace. G. L. CLARK AND H. V. ANDERSON. *Ind. Eng. Chem.*, **21** [8], 781–85 (1929).—X-ray diffraction patterns by the "powder method" have been obtained for pure quartz, ganister, fired silica brick (unused), and the various zones of silica brick after the usual service in an open-hearth furnace. The interplanar distances obtained for these materials are given together with diffraction data on low quartz (Harrington) and high cristobalite (Wycoff). The various lattice constants, as obtained from the literature, associated with these two forms of silica are given. The presence of both quartz and cristobalite in fired silica brick (unused) is definitely established. After service in an open-hearth furnace the silica brick still retains the quartz formation, although there is a greater tendency toward the cristobalite state in the hotter zones than in the cooler zones of the brick. The probable cristobalite interplanar distances are indicated. The X-ray diffraction method suggests itself as another procedure for the detection of the various forms of silica in silica refractories. R.G.M.

Refractories. ANON. *Mech. Eng.*, pp. 18–19 (Jan., 1930); *Refrac. Jour.*, **5** [53], 196 (1930).—The progress of refractories during 1929 as applied to fuel utilization is reviewed. The tunnel kiln has been adapted for the firing of fireclay, silica, and chrome brick and several new refractories have come into prominence. Progress has been made in the design of special refractory shapes for blast-furnace stoves and open-hearth regenerators. E.P.R.

Refractories. II. R. M. DOIDGE. *Blast Fur. Steel Plant*, **18** [2], 345–50 (1930).—Resistance to erosion depends chiefly on texture, chemical composition, manner in which the ingredients are blended, on firing, and other similar factors. In general, a dense, close, fine-textured, hard-fired brick is more resistant than one more open in texture, but unfortunately such a brick is more liable to spalling and cracking troubles. As to chemical composition, the tendency today is, as the service demanded from refractories becomes more severe, to use more and more highly aluminous materials. It is a matter of experience that other things being equal, a siliceous brick is eroded more rapidly by slags at high temperatures than one higher in alumina. There are few deposits of high alumina clays in Great Britain; the china clays are among the purest and most refractory but costly with maximum alumina content (fired) of about 44%. A few Scottish fire clays approach this figure and the enviable reputation of the Scottish refractories is due to these. The Ayrshire bauxite clay has no plasticity, and hence is not a clay or a bauxite, but is the most refractory material in these islands. Its manufacture into ware presents difficulties; it has to be carefully selected since the composition varies from place to place, it is nonplastic, and its firing temperatures have to be high. These difficulties are being overcome, however, and brick with this material as a base and containing up to 60% and even 70% of alumina are now on the market, and are being tested out extensively with encouraging results. For Part I see *Ceram. Abs.*, **9** [4], 283 (1930). F.P.H.

Gas-works' refractories. J. A. SUGDEN. *Refrac. Jour.*, **5** [53], 173–76 (1930).—The trend has been toward higher temperatures of carbonization. The demands on

the refractory have steadily increased, and further advance depends upon the improvement of the refractory. The first essential of a refractory material is the ability to retain its shape and strength at high temperatures. The material must be fired during manufacture to at least as high a temperature as that to which it will be subjected during use, otherwise the continued shrinkage will cause distortion or collapse of the structure. The property of thermal conductivity is an important factor in the efficient working of a setting. The refractory is called upon to act in two opposite rôles according to its position in the setting, one as a conductor of heat and the other as an insulator. In the case of the intermittent working, it is not the conductivity which is the factor involved, but rather the "diffusivity" for it is this property which determines the rate at which a body may be heated. It is related to the conductivity (K) in the following way: Diffusivity $= \frac{K}{C.S}$ where S=apparent specific gravity and C = specific heat of the material. It is a measure of the rate at which a heat wave is transmitted through the material. Retort material is exposed to the destructive action of the alkaline chlorides and volatile iron compounds, liberated by coals during carbonization. The fluxing of the surface of the refractory causes a difference in thermal expansion between the affected and unaffected portions, with a resulting increased tendency to spall. Though slagging is primarily chemical, resistance to slagging is greater with a refractory of uniform and low porosity. The mechanical strength must withstand the abrasive action of the charge and coke. Fire brick are more resistant to abrasion than silica. During scurfing, rapid combustion may cause a sudden large local rise in temperature and result in spalling. This rise in temperature during scurfing may be conveniently moderated by introduction of steam along with the air. Gasification of carbon by steam requires the absorption of heat, and will thus take up the excess heat generated by the rapid combustion. As fire brick have a comparatively low refractoriness under load their use is usually confined to those parts which are at low or moderate temperatures. In the combustion chamber, flues, and cross-walls, and in the hottest zone of a vertical retort, where the temperature exceeds 1400°C, silica is recommended. The refractory used in the producer need have only moderate refractoriness but must be resistant to the slagging action of the ash and the abrasive action of the coke. These requirements are met by a dense fire brick. The heating up of a silica setting should take three or four weeks to reach dull red heat. After dull red heat is reached the heating may be rapid. As the volume changes in a well-fired silica brick are reversible, equal care should be taken in cooling down the setting below red heat. Intermediate between fire brick and silica brick are the so-called siliceous brick. The raw materials are natural siliceous fire clays, or "clayey" silica rock. The properties of siliceous brick are usually intermediate between those of ordinary fire brick and silica brick. The weakest points in any refractory structure are the joints, and their failure is undoubtedly the beginning of most cases of retort "holing." Among the tests which should be carried out are those for working qualities, grain size, shrinkage, adherence, dry and fired strengths, and refractoriness. The most important high-temperature insulating material is kieselguhr or diatomaceous earth. E.P.R.

Penetrability of silica block, mortar joints, and brickwork by gases. ANON. *Glashütte*, **59** [46], 840–42 (1929).—All materials which contain pores allow gases to pass through them. In order to compare this property of various materials there is usually reported for them a penetrability number which gives the number of cubic meters of air passing through a block 1 m. by 1 m. by 1 cm. thick per hour, when the difference in pressure between the two sides is 1 mm. water. In silica blocks this penetrability increases linearly as the pressure is increased; for mortared walls the relation is not linear. The penetrability number for mortared walls is 50 to 100 times that of an un-

mortared silica block. The thicker the mortared wall, the better it is dried and the closer the individual blocks are to one another the lower the penetrability number. It is greatly increased even by the presence of extremely small cracks. L.T.B.

Deterioration of cement-kiln linings. MUELLER. *Zement*, **18**, 43 (1929); *Rock Prod.*, **32** [26], 98 (1929); see *Ceram. Abs.*, **9** [3], 224 (1930). W.W.M.

Silica refractories for coke ovens. R. RICHARDS. *Colliery Guardian*, 36–37 (Jan., 1930); *Refrac. Jour.*, **5** [53], 196 (1930).—For abstract see *Ceram. Abs.*, **9** [3], 199 (1930). E.P.R.

Brick for lining lime kilns. ANON. *Brit. Clayworker*, **38** [454], 405–407 (1930).—The maximum temperature attained in a lime kiln under normal conditions is about 1200°C, though in some parts of some gas-fired kilns 1400°C is reached. A recent inquiry has shown that most German firms use fireclay brick, only 3 using quartzose shale. Two tables and a number of graphs are given taken from an investigation by Hirsch on the effect of lime on six fireclay bricks. It would appear that fireclay brick containing about 20 to 30% alumina are less satisfactory for shaft kilns than are dense silica brick or fireclay brick with a much larger proportion of alumina. R.A.H.

Durability of the structure of direct-arc furnaces under different working conditions. E. KOTHNY. *Refrac. Jour.*, **4** [48], 398 (1929); for abstract see *Ceram. Abs.*, **9** [1], 44 (1930). E.P.R.

Tile suspended from pipes in new furnace roof construction. ANON. *Iron Trade Rev.*, **84**, 1713 (1929).—Particulars are given of a system of flat suspended roof construction in which 6-in. slotted pipe constitutes the primary suspending member. The method of supporting the "hanger" and "filler" brick is shown. Practically the same methods have been applied to the design of sectionally supported side walls. (*J.I.S.I.*)

History of furnace linings. E. G. WHEPLEY. *Blast. Fur. Steel Plant*, **18** [2], 288–90 (1930).—The place of the mason contractor is outlined in relation to present day plant conditions. F.P.H.

Destructive influences on refractory brick. M. PULFRICH. *Korrosion und Metallschutz*, **5**, 193–99 (1929).—P. discusses the various factors which operate on refractories and bring about their destruction. (*J.I.S.I.*)

Refractory materials. C. PRESSWOOD. *Metallurgia*, **1**, 15–16 (1929).—The importance of refractory materials in metallurgy and the general principles governing their selection and use are discussed. (*J.I.S.I.*)

Bonded refractory. JOHN D. MORGAN. *Refrac. Jour.*, **5** [53], 196 (1930); see *Ceram. Abs.*, **9** [1], 47 (1930). E.P.R.

Investigations on slagging of refractory materials. III. Slagging of magnesite. RUDOLF MIKSCH AND HERMANN SALMANG. *Arch. Eisenhüttenwesen*, **3**, 313–18 (1929).—The action (corrosion, infiltration, etc.) of various simple and complex slags on magnesite crucibles is studied at 1550° and 1650°. Singly, K_2O, Na_2O, PbO, FeO, Fe_2O_3, MnO, Mn_2O_3, Al_2O_3, SiO_2, and CaS do not attack, while P_2O_5 and B_2O_3 do so strongly. A corroding action is shown only by binary or ternary slags which contain either P_2O_5, B_2O_3, SiO_2 or Al_2O_3 (to a lesser extent) in excess. Smaller amounts of FeO and CaO in ternary slags cause stronger attack than do larger amounts (the effect of CaO is the greater), while the reverse is true with MnO. The attack of ternary slags is less than that of the binary, this being further decreased by the addition of other components. Both the corrosion and infiltration of slags (FeO, F_2O_3, MnO show no attack) is increased by raising the temperature from 1550 to 1650°. That magnesite is less easily slagged than is fire clay is explained by the assumption that it loses its strongly basic character at these temperatures. (*C.A.*)

Refractories; their properties and adaptabilities. LOUIS N. RANCKE. *Amer. Gas*

Jour., **127** [7], 35–39 (1927).—The behavior of numerous types of refractories used in the gas industry is described. The properties which govern their resistance to chemical or physical disintegration are discussed. Suggestions are made as to failures not chargeable to the refractory materials also methods of prolonging the life of refractories. Some highly siliceous clays of Md. and N. J. hitherto but sparingly used have the proper qualifications for refractories in the gas industry. (*C.A.*)

Special refractories (chromite, bauxite, and silicon carbide, zircon, silicon carbide brick). E. H. SCHULZ AND A. KANZ. *Mitt. Forsch. Inst. Ver. Stahlwerke Aktien Ges. Dortmund*, **1** [2], 23–63 (1928).—The discussion included the properties and preparation of the raw materials and the general processes of manufacturing the refractories. The comparison of the several types included, beside the usual physical and chemical tests, refractoriness under load, thermal expansion, resistance to slag attack, to prolonged heating, and to quenching. The chromite brick had high Seger cone m.p., good resistance to slag action, high thermal expansion, but low resistance to quenching. Bauxite brick showed high m.p., good refractoriness under load, and fair resistance to quenching and to slag. Corundum refractories showed comparable properties. The zirconium refractories were of lower m.p., had poor resistance to prolonged heat with or without load, but resisted quenching and slag attack well. The SiC brick were especially resistant to thermal shock, slag, and high temperatures, if reducing conditions were maintained. (*C.A.*)

Comparative effects of frits, glass, soda, and sulphate on grog blocks. P. P. BUDNIKOFF. *Tonind.-Ztg.*, **54** [1], 17 (1930); for abstract see *Ceram. Abs.*, **9** [4], 283 (1930). M.V.K.

Alumina as a refractory material for furnace construction. GEORG MARS. *Arch. Eisenhüttenwesen*, **3**, 249–51 (1929).—From considerations of the freezing diagrams of the Al_2O_3–SiO_2, Al_2O_3–CaO, and CaO–SiO_2 systems, and from chemical and physical characteristics, it is shown that a hearth with 90% CaO and 10% Al_2O_3 is the superior. With a hearth of this composition faultless fusions are obtained in every respect, it has excellent dephosphorizing, desulphurizing, and deoxidizing power. It is more resistive to reduction influences than the magnesite hearth. Advantages and disadvantages of acid and basic furnace construction materials are briefly considered. (*C.A.*)

Magnesia refractories. ANON. *Fuel Economist*, **4**, 527–28 (1929).—Particulars are given of the characteristics of magnesia refractories. (*J.I.S.I.*)

Magnesite crucibles. ANON. *Refrac. Jour.*, **5** [53], 165 (1930).—Experiments made by Roure, of the high school of foundry, on superheating of cast iron, found that no refractories can resist the temperatures obtained. Le Thomas stated that some refractories had been obtained which could resist up to 1710°C. Portevin said that he had used crucibles of specially prepared magnesite which had resisted up to 2200°, but only small crucibles can be made in such a way. E.P.R.

Electrical conductivity of magnesite and other refractory materials in relation to temperature. E. DIEPSCHLAG AND E. WULFESTIEG. *Engineering*, **128**, 385 (1929); for abstract see *Ceram. Abs.*, **9** [4], 280 (1930). H.H.S.

Diaphragms of insulating material. C. E. MARSHALL. *Jour. Soc. Chem. Ind.*, **48T**, 373–74 (1929).—The complete description of a diaphragm from a colloid-chemical point of view must define its hydrodynamic, electrokinetic, and adsorptive properties under given conditions. Only the first two of these are considered here. The method developed depends on the simultaneous application of Poiseuille's law and Ohm's law; the diaphragm is defined in terms of K (Poiseuille constant) and l/q, the cell constant. H.H.S.

Resistance of refractories to thermal spalling action and their testing. O. PHILIPP.

Tonind.-Ztg., **54** [4], 54–56; [5], 75–76 (1930).—P. discusses the experiments made by Goodrich, Parmelee, Westman, and others. M.V.K.

Fusion point of coal ash. J. G. KING, A. BLAKIE, AND J. O. MILLOTT. Dept. Sci. and Ind. Research, Fuel Research, *Tech. Paper*, No. 23 (1929).—The authors describe in detail the furnaces and methods which have been evolved for the determination of (1) the temperature of initial deformation (softening point), and (2) the fusion temperature (complete fusion point), under both oxidizing and reducing conditions. Results of analyses and fusion-point determinations are tabulated for specimens of ash from ten American coals ranging from sub-bituminous coal to anthracite, and from ten representative British coals selected from various coal fields. (*J.I.S.I.*)

Heat resistance. ANON. *Refrac. Jour.*, **5** [53], 192–95 (1930).—The introduction of oil fuel for marine boilers in about 1910 uncovered many new problems in furnace design. One of the most persistent difficulties was the problem of securing satisfactory anchorage for refractory brick linings. The fuel-oil testing plant at the Philadelphia Navy Yard conducted exhaustive tests with many different metals in a search for a satisfactory material to withstand the conditions. It included bolts manufactured of every available heat-resisting alloy. A special alloy of nickel with a small percentage of manganese, which had long been used for electrode wires of automobile spark plugs, was finally determined to be the most efficient and economical of all the materials tested. Conjointly with the Babcock and Wilcox Co., the builders of the Malolo specified the use of forged manganese-nickel bolts for anchoring the new improved B. and W. No. 80 refractory brick, and an interlining of $4^1/_2$ in. diatomaceous earth insulating brick. E.P.R.

Cyanite in North Carolina, occurrence and applications. A. F. GREAVES-WALKER. *Eng. Mining Jour.*, **129** [4], 173–74 (1930).—Cyanite ($Al_2O_3 \cdot SiO_2$) is one of the minerals of the sillimanite group. It is valuable because when fired it inverts to mullite ($3Al_2O_3 \cdot 2SiO_2$) and glass. Mullite has (1) high resistance to thermal shock, (2) high dielectric strength, and (3) refractoriness. Cyanite crystallizes in the triclinic system, has a hardness of 4 to 7.5, is gray through blue to brown, and has a melting point at 1545 °C. N. C. and Va. cyanite deposits occur in the eastern crystalline belt of the Southern Appalachians in the Carolina gneiss. In N. C. it occurs from Yancey to Buncombe counties. Three types of deposits occur: (1) disseminated, (2) veins, and (3) lenses, the first type being the most common. Disseminated deposits contain about 40% ore. E.C.C.

Graphite. BENJAMIN L. MILLER. *Eng. Mining Jour.*, **129** [3], 118 (1930). E.C.C.

Bauxite in British Guiana. ANON. *Times Eng.* [Supp.], **25**, 274 (1929).—A British company has secured a concession to win bauxite near the Demerara river. H.H.S.

Canadian magnesite industry. ANON. *Refrac. Jour.*, **5** [53], 195 (1930).—The magnesite industry of Greenville, Quebec, which was unable to meet competition from Austria and Calif., has been revived owing to improved processes discovered by the National Research Council of Canada. A method was worked out for securing a product of higher grade and for increasing the proportion of rock commercially used without great expense or radical plant changes. Commercial uses were found for the materials previously treated as waste. E.P.R.

BOOK

Heat Insulation in Theory and in Practice. ANON. Published by Julius Springer, Berlin. Written in German. Reviewed in *Chaleur ind.*, **10**, 466 (1929).—The transmission of heat, design of heat insulating installations, insulating materials, and testing of heat insulators are discussed in this book. A.J.M.

PATENTS

Furnace wall. DAVID S. JACOBUS. U. S. 1,749,768, March 11, 1930. In a furnace, a wall, a support, and a connection between the wall and support comprising a member having substantially parallel legs joined by a portion of approximately semi-cylindrical shape.

Construction of furnace or oven arches. ALEXIS CONSTANT RAGOUCY. U. S. 1,750,355, March 11, 1930. In a ceramic or tile furnace in combination with lateral walls, a flat slab resting on the walls and serving as a continuous stay for the arch, refractory brick arranged in rows, forming a substantially flat roof for the oven and provided with transverse openings, suspension members depending from the slab, the lower end of each of the members being disposed at the junction of a pair of adjacent brick of a row, and a tube carried by the suspension members and the opposite ends of which tube enter the openings of the adjacent brick the suspension elements being each provided with a ring freely engaged on the tube.

Treating refractory material. EARL LEESON HAUMAN. U. S. 1,750,468, March 11, 1930. In a step-by-step retort of the class described, an arch, a material support adjustable relative to the arch and means for progressively lowering the support to maintain the surface of successive layers of material in predetermined spaced relation thereto.

Cooling furnace walls. RICHARD LA FRANCE. U. S. 1,751,008, March 18, 1930. Combination of a tank wall having a series of vertically extending channels in its outer surface, means arranged to direct a cooling medium into the lower ends of and upwardly through the channels, closure plates rising vertically from the means and positioned to confine the cooling medium in the channel, the plates terminating short of the upper end of the channel to provide exhaust ports for the cooling medium, and means to removably secure the plates in the position.

Furnace construction. ALFRED WILLIAM BENNIS. U. S. 1,751,188, March 18, 1930. A boiler furnace comprising an overhead frame work, tension bars depending from the frame work, walls solely supported upon the tension bars, protective tubes around the tension bars, and means whereby air may be passed through the space between the tubes and the bars.

Applying refractory cement. LEON FABER. U. S. 1,751,195, March 18, 1930. Apparatus for applying plastic material comprising a head having therein a chamber, a discharge passage from the chamber increasing in area outwardly from the chamber, an inlet passage to the chamber for compressed air or vapor aligned with the discharge passage, and a second inlet passage to the chamber, a tube communicating with the second inlet passage, and an air conduit communicating at one end with the interior of the tube adjacent its intake end, the other end of the conduit being arranged to open to the atmosphere when the intake end of the tube is immersed in the plastic material, whereby compressed air or vapor admitted through the first inlet passage serves to produce a flow of plastic material and air through the tube into the chamber and to discharge the same therefrom through the discharge passage.

Manufacture of refractory basic brick, etc. CECIL STEVENSON GARNETT. U. S. 1,751,234, March 18, 1930. Process of manufacturing brick from dolomite, which consists in calcining the dolomite until it contains 8 to 12% by weight of carbon dioxide grinding the calcined dolomite, adding thereto a substance calculated to prevent hydration of the finished article, adding water to the mixture, molding the mixture into the required shape, drying the same, and firing.

Applying plastic material to surfaces. JOHN R. MACK. U. S. 1,751,343, March 18, 1930. (1) A cement sprayer including an ejector nozzle, a cement chamber at the inner end of the nozzle in alignment therewith, and a restricted fluid pressure nozzle

passing through the cement chamber and having a divergent end portion terminating adjacent the inner end of the ejector nozzle, the fluid pressure nozzle being adjustable in the cement chamber toward or away from the ejector nozzle, and means on the exterior of the sprayer for adjusting the fluid pressure nozzle. (2) Method of providing a surface with a coating of plastic material having a consistency sufficient to preclude washing, which consists in diluting the plastic material with air at less than atmospheric pressure, then drawing the plastic material through a conduit by aspiration and projecting it on the surface by means of a jet of gas directed through a nozzle against the surface to be coated.

Magnesite brick. BENABENQ. Fr. 620,203; *Refrac. Jour.*, **5** [53], 196 (1930).—It is proposed to produce a magnesite, dolomite, or lime brick by sintering the raw materials, pulverizing, and mixing with 30% of powdered alkali chloride. After molding at high pressure, the firing is carried out at 1700°C over a period of 30 to 40 hours. E.P.R.

Production of green corundum. A. KRATKY. Austr. 108,704, May 22, 1926. A mixture of pure alumina with a trace of cobalt-zinc oxide green pigment is melted in an oxyhydrogen flame to which is fed a small quantity of air to avoid overheating the charge and consequent volatilization of the zinc oxide. A similar result is obtained by adding to the alumina small quantities of a colorless substance which reduces the melting point of the product. (*B.C.A.*)

Shaping fused amorphous quartz. DEUTS. ENGLISCHE QUARZSCHMELZE G.M.B.H. Ger. 455,305, Jan. 17, 1926. Powdered or granular residues from the manufacture of fused silica ware are mixed with acid-resisting silicate cements, *e.g.*, water-glass; the mixture is molded, the shapes are pickled in acid, and the surface is fused over in known manner. (*B.C.A.*)

Synthetic spinels. WIEDE'S CARBIDWERK FREYUNG M.B.H. Fr. 667,195, Jan. 10, 1929. To a mixture of Al_2O_3 and MgO are added substances containing metals of the Fe group, with or without compounds of Be and Ti; the mixture is caused to crystallize according to the process of Verneuil (*Compt. Rend.*, **135**, 791 (1902). (*C.A.*)

Terra Cotta

Clay products in modern environment. ANON. *Brick Clay Rec.*, **76** [5], 316–17 (1930).—Photos illustrating examples of modern architecture employing clay products are presented. They include buildings in Los Angeles, Calif., New York, and Seattle, Wash. Brick and terra cotta are the materials used in the construction of these buildings. E.J.V.

Polishing stoneware. FELIX SINGER. *Glastech. Ber.*, **7** [4], 146 (1929).—The methods and materials used in polishing stoneware are described briefly. E.J.V.

BOOK

Building Construction. GEORGE A. HOOL AND NATHAN C. JOHNSON. *Arch. Rec.*, **67** [1], 156 (1930).—The first volume covers the mathematical theory of structural design, members and details, and structural data. The second volume covers contractors' methods and equipment, estimating, contracts, building materials, and mechanical equipment of buildings; see also *Ceram. Abs.*, **8** [12], 900 (1929). E.P.R.

PATENT

Decorating pottery. V. G. H. ALCOCK, W. LINDLEY, AND W. BLOORE. Brit. 323,633, Feb. 26, 1930. Articles of pottery are decorated while rotating by means of nozzles supplied with slip from a container delivering by gravity. A tap near one end

of the flexible pipe controls the flow. The nozzle may have two holes, for the simultaneous deposit of two separate decorative bands. In operation the nozzles are directed so that the stream of material forming the band misses the spouts and handles of teapots and like articles, thus allowing the decoration to be performed after the attachment of these accessories.

White Wares

A simplified practice of mixing colored glazes. V. J. ROEHM. *Jour. Amer. Ceram. Soc.*, **13** [4], 285–86 (1930); for abstract see *Ceram. Abs.*, **9** [3], 210 (1930).

Chinaware tested at Bureau of Standards. ANON. *Commercial Stand. Monthly*, **6** [8], 245 (1930).—Chinaware for use in the various government departments and bureaus is purchased upon Federal Specifications which cover certain required physical properties, such as size, weight, amount of water absorption, and strength. The strength is measured by testing the ware on an impact machine. Two tests, resistance to chipping and resistance to impact, are made. Two machines have been designed and are used for this testing. The principal feature of the machines is a swinging pendulum to strike the ware with blows of increasing force, measured by the weight of the pendulum and the distance through which it falls, until the test piece breaks. A comparative study of the two machines and of domestic and foreign ware has been made. There appears to be no definite relation between the thickness of the ware and its strength or between the percentage of water absorption and strength. Domestic ware seems to be stronger than foreign-made ware. Some of the domestic semiporcelain (earthenware) bodies appear to be stronger than foreign-made vitreous ware. Chipping values do not seem to bear any direct relation to impact values. Competitive tests such as these tend to cause the manufacturers to improve their methods of production resulting in the production of better and stronger dinnerware. E.J.V.

Vitreous china plumbing fixtures. ANON. *Commercial Stand. Monthly*, **6** [8], 255 (1930).—The recommended commercial standard for vitreous china plumbing fixtures was circulated during January among producers, distributors, and users for written acceptance. Although a simplified list of a variety of vitreous china plumbing fixtures is included the primary purpose is to establish nomenclature, definitions, and grading rules as a basis for marketing the commodity, and therefore, upon request of the industry, the revision is being handled as a commercial standard project. This recommended standard incorporates a number of additional requirements intended to clarify the general understanding between producers and consumers. E.J.V.

Occurrence of talc and its use in whiteware industry. ANON. *Keramos*, **8** [24–25], 919–26 (1929).—Occurrence, composition, and properties of certain European steatites are described. A review of the literature on the use of talc and steatite in whiteware bodies is made. F.P.H.

Porcelain insulators and insulator porcelain. STEN VELANDER. *Electrician*, **104**, 129–33 (1930).—A review discussing the electrical and mechanical stresses, effect of salt storms, improvements in porcelain, etc. (*C.A.*)

Process control in continuous production. F. H. RIDDLE AND H. F. ROYAL. *Ind. Eng. Chem.*, **22** [1], 14–20 (1930).—The authors describe the development of process control at the plant of the Champion Porcelain Co. R.G.M.

PATENTS

Manufacture of ceramic ware. JOSEPH WILLIAM MELLOR. U. S. 1,749,642, March 4, 1930. A body material for making ceramic ware which consists of normal body material, sodium-calcium silicate, and combined boric oxide, so that the body matures at temperatures approximating to those normally employed for maturing glazes.

Testing insulators. ARTHUR O. AUSTIN. U. S. 1,750,699, March 18, 1930. An insulator testing device, comprising a housing, means for supporting an insulator within the housing, a pair of terminals for subjecting the insulator to electric pressure while within the housing, and means for supplying air pressure to the interior of the housing, the terminals being separated at their point of closest approach by the insulator when in test position.

Insulator pin. ARTHUR O. AUSTIN. U. S. 1,750,769, March 18, 1930. (1) An insulator pin having rolled threads thereon, the points of which project outwardly beyond the periphery of the unthreaded portion of the pin while the roots of the threads extend inwardly beyond the peripheral surface of the unthreaded portion of the pin, and a support having a threaded opening meshing with the tips of the threads of the pin but having a minimum diameter large enough to receive the unthreaded portion of the pin. (2) An insulator pin having a radially extending portion between the ends thereof and a flange secured to the portion, the flange having the upper extremity thereof formed inwardly over the extending portion substantially throughout the peripheral extent of the portion to enclose the extending portion and lock the flange to the pin.

Insulator pin. ARTHUR O. AUSTIN. U. S. 1,750,770, March 18, 1930. An insulator support comprising a rod of substantially uniform cross-sectional area throughout its length, the rod having a portion of the metal thereof pinched outwardly at a point between the ends of the rod to provide oppositely disposed outwardly-projecting flanges substantially equal in circumferential width to the ribs of metal left between the flanges, a support for the pin having a sleeve portion, and a radially extending flange connected with the sleeve portion, the sleeve portion having a circumferential recess in the top thereof for receiving the projecting flanges, there being a projection extending into the recess for engaging the projecting flanges on the pin to limit rotation of the pin in the sleeve, the portion of the pin below the sleeve being substantially equal in diameter to the portion of the pin above the outwardly extending flanges.

Condenser lightning protection device. ARTHUR O. AUSTIN. U. S. 1,750,771, March 18, 1930. Combination with a transmission line and electrical apparatus connected therewith of a resistance element connected in series between the line and apparatus for protecting the apparatus against excess current due to high frequency disturbances on the line, and means for diverting current from the resistance element to ground, the means comprising a grounded conductor spaced from the resistance element and extending along the length thereof, and a dielectric member interposed between the resistance element and grounded conductor and forming with the element and conductor a condenser, the capacitance of the condenser and the impedance of the resistance element being sufficient to divert enough of the energy of disturbances on the line to protect the apparatus from injury for all voltages against which the protecting apparatus is designed to proteet the apparatus, the resistance element being sufficiently insulated from ground to prevent arcing to ground for such voltages.

Water closet. ULYSSES G. LEE. U. S. 1,750,779, March 18, 1930. In a water closet, a bowl, a discharge passage from the bowl, a water jet for the discharge passage, and a valve between the jet and bowl.

Flushing for water closets. PAUL E. GEORGIOU. U. S. 1,751,145, March 18, 1930. A water closet comprising a pneumatic compression reservoir for storing water to flush the bowl, a pipe connecting the reservoir with the rim of the bowl for conducting the flushing water thereinto, a valve in the pipe between the reservoir and the rim of the bowl, a water compartment in which the valve is located provided with overflow and drainage openings and having a capacity sufficient to supply the water seal for the bowl, means adapted to be manipulated by the user for opening the valve and means

associated with the valve for filling the compartment when the valve is opened for flushing the bowl.

Equipment and Apparatus

Laboratory box for drying ceramic ware. P. P. BUDNIKOFF. *Ceramics and Glass* [Moscow], **5** [5], 187 (1929).—The construction of a simple box serving for drying ceramic ware is described. Such a box has been used by B. for more then $1^1/_2$ years with good results. The box is made from dry pine wood, its height being 1 m. 20 cm., width 0.5 m., and depth 45 cm.; empty spaces left at the sides of the box have a width of 20 cm. The air enters through two openings made in the bottom of the side spaces; electric lamps (each of 200 candles) secured in each side space heat the passing air. The air absorbs the moisture of the drying ware, sinks down, passes the three shelves made of sheet iron and provided with holes, and escapes through an iron pipe. For obtaining a better draft an electric lamp is placed inside of this pipe. The shelves may be lowered or raised. A small glass window is made in the box opposite each shelf. The electric lamps may be turned off or on separately. In case all the lamps are lighted the temperature of the upper shelf is from 65 to 70°C, of the second shelf from 60 to 65°C, and of the third, from 34 to 40°C. A picture of the box is given. W.A.

New advance drying device. ANON. *Brit. Clayworker*, **38** [454], 404–405 (1930).—The process of advance drying, warming, or steaming in continuous kilns was an adjunct found necessary in the earliest days of the Hoffman kiln. The difficulties which arise in connection with the satisfactory removal of moisture from the green product and the equal distribution of hot air to all parts of the drying chamber are discussed. The new device, the "Neuero" hot-air advance drying machine, is characterized by the use of a small electrically-driven blower with a motor of 2 H.P. A central hot-air duct of ample cross-section is constructed, as usual, along the center of the kiln and is connected with the cooling chamber by means of sheet-metal tubing with inlets attached to the feed holes of the chamber. By means of two sheet-metal adjustable tubes, hot air is drawn by the small fan and distributed to the required number of feed holes of the newly set chamber by means of small flexible tubular branches off the main delivery tube. The tubes are insulated by means of sheet asbestos, and the small branches are furnished with conical nozzles, adapted to be self fitting into the feed hole caps. They can be controlled by dampers. Hot air is then blown under pressure through the holes in the arch of the chamber, and after passing among the goods, leaves them either by apertures at the bottom of the wicket filling or by the ordinary flue openings. A marked economy of coal consumption is effected and the speed of fire travel increased. R.A.H.

Automatic flow regulators for regulation of heating apparatus. ROGER MARTIN. *Chaleur ind.*, **10**, 361–65 (1929). A.J.M.

Constant ratio between thermal and electrical conductivities of metals. A. GREBEL. *Chaleur ind.*, **10**, 569–71 (1929).—A constant ratio between electrical conductivity and thermal conductivity has been shown to exist for silver, copper, gold, aluminum, nickel, iron, platinum, lead, and mercury in the temperature range 0 to 100°C. This ratio is equal to approximately 16 cm.^{2} ohm seconds. The ratio between the two conductivities may be expressed as follows: $\gamma = 3.3\left(\frac{R}{N \times e}\right)T$ where R = the gas constant, N = Avogadro's number, e = the charge on the electron, and T is the absolute temperature. R must be expressed in ergs and e in electromagnetic units. A.J.M.

Air preheaters. WILHELM GUMZ. *Arch. Wärmewirt.*, March, 1929; *Chaleur ind.*, **10**, 513 (1929). A.J.M.

Air separation effective in nonmetallic mineral industries. RUBERT M. GAY.

Eng. Mining Jour., **129** [2], 65–68 (1930).—A summary of the development of the air separator for quartz, feldspar, talc, cement, limestone, kaolin, etc. Illustrations and flow sheets for different types of separators and milling systems are given along with a discussion of their merits. E.C.C.

Rapid-indicating, continuous-reading vacuum and pressure gages. H. G. Anderson. *Ind. Eng. Chem.*, **21** [8], 795–97 (1929).—Two gages are described which were developed for measuring pressures continuously and at high speeds. These gages will withstand a change of pressure from atmospheric to zero without injury. Pressure measurements are made almost instantly. The No. 2 gage has a comparatively high sensitivity for pressures between 20 and 1 mm. or below. With the exception of the three positions for pointer movements across the scale of the No. 2 gage, no manipulations are required during a course of measurements. A separate calibration is required for each gas. The gages, being rugged, do not require skilled hands in using them. R.G.M.

Mechanical handling of materials in and about the chemical plant. II. Belt conveyers. A. K. Burditt and W. F. Schaphorst. *Ind. Eng. Chem.*, **21** [7], 649–54 (1929).—A description is given of various types of belt conveyers in use in chemical or similar plants with photographs of such equipment in operation. Tables of pulley diameters, speeds and capacities of belts, etc., are included. **III. Conveyers and mechanical handling equipment.** *Ibid.*, **21** [9], 844–50 (1929).—The authors describe the uses for (1) flight conveyers, (2) gravity systems, (3) screw conveyers, and (4) pneumatic conveyers. Other types of conveyers mentioned are (1) drag scrapers, (2) skip hoists, (3) monorail systems, (4) trucks, and (5) cranes. Whenever there is a constant flow of materials in unloading processing, packing, or shipping, mechanical handling can show labor savings of from 50 to nearly 100%, with a consequent large reduction in handling costs. For Part I see *Ceram. Abs.*, **9** [3], 216 (1930). R.G.M.

Machinery in potteries. H. S. Newman. *Pottery Gaz.*, **55** [633], 459–62 (1930).—Some interesting details in relation to various types of machinery used in potteries, with special emphasis upon the appliances utilized in connection with the manufacture of electrical porcelain are given. The manufacturer of pottery is called upon to have an intimate knowledge of potting, works management, and engineering equipment, and also of the principles of applied mechanics. In the case of the manufacture of electrical porcelain, in addition to all this, it is necessary that one should have more than a mere smattering of the principles underlying the present high-tension distribution. The growth of the high-tension transmission of electrical energy is giving rise to more severe specifications in their expressed terms, and a point is being reached where difficulty is had to meet the desired conditions. Among the topics discussed are (1) preparation of raw materials; (2) pan mill vs. ball mill; (3) blunging, sifting, and mixing; (4) magnetic separation; (5) slip pumps; (6) filter presses and pug mills; (7) throwing and turning; (8) jolleying; (9) dies for dust-pressing; (10) types of sagger-making machines; (11) mechanical propulsion for tunnel kilns; (12) incidental machinery; and (13) driving gear in potteries. E.J.V.

Industrial measurements. I. Weighing. E. P. Partridge. *Ind. Eng. Chem.*, **21** [8], 740–44 (1929).—P. describes and discusses weighing devices now available for many types of weighing requirements. The chief requisites of an industrial weighing mechanism are accuracy, ruggedness, speed of weighing, and elimination of errors in reading. The trend in the U. S. at the present time is predominantly in favor of the automatic handling processes. R.G.M.

Alloys that resist heat. T. H. Nelson. *Iron Age*, **125** [6], 431–34 (1930).—Describes heat- and corrosion-resisting alloys and their chemical and physical relations. E.C.C.

Caterpillar dragline operations. ANON. *Pit and Quarry*, **19** [10], 89 (1930).—A dragline scraper is a digging, conveying, and self-dumping tool which can be controlled and operated entirely by a one-man crew. A two-drum hoist, such as the Willamette-Ersted "Hyster," mounted on a "Caterpillar" tractor, is an ideal power unit for operating this scraper and will move dirt for distances up to 350 ft. The average and most economical operating span is about 200 ft. The scraper is controlled with two clutch levers which operate the two drums of the hoist; one hauls in the loaded scraper and the other hauls it back when empty. E.P.R.

Laboratory investigation of ball milling. A. M. GOW, A. B. CAMPBELL, AND W. H. COGHILL. Amer. Inst. Mining and Met., Eng., *Tech. Pub.*, No. 326, Class B; *Mining and Met.*, **11** [279], 22 (1930).—A new theory of ball action is advanced from a study of a 3-ft. squirrel-cage mill and a new formula of ball paths is derived. Laboratory tests with short mills in which slippage was reduced to a minimum show that the best grinding results were obtained at lower speeds than those hypothecated by previous theories. A speed of 65% of the critical gave the maximum grinding, while a speed of only 50% of the critical gave the most efficient grinding. By comparing the grinding results of the mills of various diameters, it was found that at the same per cent of the critical speed (*a*) the units of surface per unit weight varied as the 0.6 power of the diameter; (*b*) the surface tons, or grinding capacity, varied as the 2.6 power of the diameter; (*c*) the horsepower also varied as the 2.6 power of the diameter; (*d*) the surface tons per horsepower-hour, or efficiency of grinding, was constant regardless of the diameter; and (*e*) the units of surface per unit weight varied approximately as the peripheral speed. The larger mills showed larger grinding capacity per unit volume, but no increase in grinding efficiency. F.P.H.

Electrical tester shows presence of inflammable gas. ANON. *Gas-Age Rec.*, **65** [8], 248 (1930).—The device makes use of a heated metallic filament connected in one arm of a Wheatstone bridge circuit. The burning of a combustible gas on the surface of a heated filament causes an increase in the temperature and resistance of the filament. The combustion throws the bridge circuit out of balance, and current flows through the galvanometer causing a deflection of the needle. The magnitude of this deflection is dependent upon the concentration of the combustible component. F.P.H.

Thermocouple design for rotary kilns or driers. A. F. GILL. *Can. Chem. Met.*, **14** [3], 22 (1930).—Difficulties are avoided by carrying the couple a distance greater than the maximum depth of charge. In this way the tip is at all times clear of the charge, and need have no protection against abrasion. It could be protected against corrosion by a thin cap of high thermal conductivity. The part in contact with the charge may be protected with a refractory abrasive jacket. The lead wires could be connected through brush and ring contacts on the kiln shell. An arrangement of this type could be made very rugged, and at the same time give relatively sensitive temperature readings. E.J.V.

New microscope and attachment designs. ANON. *Can. Chem. Met.*, **14** [3], 41 (1930).—The latest research microscope of the Bausch & Lomb Optical Co. has new features of general interest and value. Among the new ideas in design is the inclined position of the binocular eye-pieces permitting a comfortable attitude on the observer's part. The stage is directly in front of the operator, permitting more convenient manipulation of objects. The new type of instrument takes much weight off the adjustment parts, which is a matter of importance when working at high magnifications or when making long exposures in photomicrographic work. A supplementary condenser on a swing arm is a novel sub-stage feature. E.J.V.

Anti-frictioning of heavy-duty clay machinery. L. M. KLINEDINST. *Brick Clay*

Rec., **76** [5], 307–10 (1930).—Tentative applications of anti-friction bearings on heavy-duty clay machinery showed that the predictions made as to the effect thereof on the operation of the machines were, if anything, far short of the actuality. In addition to effecting a material reduction in power demand, which was probably the original idea back of their application, they brought about other decidedly important improvements, both practical and economical. As far as either load characteristics or service requirements go, dry pans form about as difficult a problem in bearing application as exists among process machines. Nevertheless more or less conventional mountings involving the use of tapered roller bearings have been developed for several positions on dry pans. These applications include the step bearing, the main shaft guide bearing, the muller wheel bearings, and the drive shaft bearings. Brick machines, whether combinations, or taken separately, present three major sets of bearing problems. These are, briefly, those concerning auger shafts, pugmill shafts, and driving shafts, respectively. Different types of mountings of anti-friction bearings for these various problems are discussed and some are illustrated. E.J.V.

New dead-weight testing machine of 100,000 pounds capacity. L. B. TUCKERMAN, HERBERT L. WHITTEMORE, AND SERGE N. PETRENKO. Bur. Stand., *Jour. Research*, **4** [2], 261–64 (1930).—The different methods of calibrating testing machines (A.S.T.M. specifications) are given, and the limitations of each are discussed. The development of the proving ring is mentioned, and the need for apparatus for applying, preferably by dead weights, forces which are known accurately is brought out. The dead-weight machine, capacity 100,000 lbs., which has been installed at the Bureau is described and illustrated. Particular attention is given to the accuracy of the forces which can be applied by this machine and the precautions for maintaining the accuracy. R.A.H.

Prevention of corrosion by electrodeposition. VI. Nickel plating as a corrosion preventive. S. WERNICK. *Ind. Chemist*, **5**, 106–10 (1929).—A general review of experiments and improvements of recent years in Ni plating. See following abstract. (*C.A.*)

Prevention of corrosion by electrodeposition. VII. Chromium plating as a corrosion preventive. S. WERNICK. *Ind. Chemist*, **5**, 524–27(1929).—A review of Cr plating. Points covered include: protective properties, porosity, the effect of composition of the solution, influence of the undercoat, after-treatment of deposits, and resistance to chemicals. (*C.A.*)

Mechanical handling. ANON. *Brick Clay Rec.*, **76** [5], 321 (1930).—At the Harbison-Walker Refractories Co. plant at Templeton, Pa., an overhead monorail motor-driven bucket, guided by hand from the floor, delivers the coal to stoker hoppers and also removes the ashes. A great saving in labor is effected by its use, for one man can easily take care of 24 stokers on two kilns, the arrangement doing away with all dirt and muss. A portable electric stacker for handling finished products is used at the Kier Fire Brick Co., Salina, Pa. The machine is equipped with an elevating platform which will lift a wheeler and loaded barrow 6 feet, the height of a tier of brick hand stacked from the floor, thus serving to double the storage capacity without added labor of handling or the necessity of tossing. At the plant of Zerrener Bros., New London, Wis., a device for returning empty pallets to the machine is used. E.J.V.

Telescoping gages. ANON. *Abrasive Ind.*, **11** [3], 43 (1930).—The Brown & Sharpe Mfg. Co. recently announced a new tool for use with a micrometer to determine internal measurements formerly difficult to obtain. The telescoping gages are comprised of five heads which are interchangeable on one handle. The telescoping head is inserted into the hole or slot to be measured where it expands to the exact size

of the hole. A turn of the knurled screw on the end of the handle locks the head and the gage is then removed and measured with a micrometer. E.P.R.

Improved rotary brick press announced. ANON. *Pit and Quarry*, **19** [10], 92 (1930).—W. A. Riddell Co. has a new press of eight double molds, giving a rated capacity of 3000 brick per hour, making pressed brick from semi-dry, granular, or pulverized material and operating under very heavy working pressure. An automatic relief device releases when the pressure reaches 225 T. E.P.R.

Removal of iron particles from ceramic body materials. ANON. *Keramos*, **9** [1], 15–18 (1930).—The various types of electro-magnets manufactured by the Elektromagnetische Gesellschaft in Elsterwerda, Germany, are described and illustrated. F.P.H.

Temperature measuring devices in ceramic and glass plants. ANON. *Keramos*, **8** [26], 965–68 (1929).—The "Pyropto" optical pyrometer and the "Pyrradio" radiation pyrometer manufactured by Hartmann and Braun. A.-G., Frankfurt a. M. are described and their applications in the ceramic and glass plants illustrated. F.P.H.

Developments in sifting technique. ANON. *Glashütte*, **60** [1], 10–11 (1930).—Description of an air separator, "Ventoplax," made by the Alpine Machine A.-G. of Augsburg, Germany, which improves the efficiency of the sifting process by 30 to 50% over the old methods. L.T.B.

Gravitational flow of fertilizers and other comminuted solids. W. E. DEMING AND A. L. MEHRING. *Ind. Eng. Chem.*, **21** [7], 661–65 (1929).—An expression giving the rate of gravity flow of comminuted solids from bins or hoppers has been derived. The time for a given mass of material to flow as calculated from this formula agrees closely with that determined experimentally over a wide range of conditions. The experimental materials included crystallized urea and ammonium phosphate, crushed phosphate rock, potassium nitrate pellets, glass beads, lead shot, marbles, and several varieties of seed. The rate of flow of such materials is found to depend upon the average particle size, the kinetic coefficient of friction and apparent density of the material, the diameter of the opening and the vertical angle of the hopper or, if all of the material does not flow out, the angle between the opposite slopes of the remaining material at repose. R.G.M.

Aerial tramway transports raw material five miles. ANON. *Pit and Quarry*, **19** [12], 51–57 (1930).—The magnesite quarries and the calcining plant of the Northwest Magnesite Co. are connected by an aerial tramway 5 mi. in length and by a road 7 mi. long. The magnesite lens is about 1000 ft. in length and 250 ft. in maximum width, ranging from dolomite to magnesite, with varying amounts of silica as an impurity. Commercial success has been due, in part, to the cheap transportation from quarry to calcining plant by an aerial tramway. The tramway is driven by a 50-H.P. motor, with some assistance by gravity. It is provided with 100 buckets, each of 1200-lb. capacity, and will deliver 200 T. in 8 hrs. A $^{5}/_{8}$-in. haulage rope is employed; and the tram track is made up of locked-coil cables of $1^{3}/_{8}$-in. and 1-in. diam. The tramway cost approximately $60,000. The plant is described in detail. E.P.R.

BOOKS

Centrifugal Pumps. C. PFLEIDERER. Translated by Bergeron. 508 pp., 355 figures. Published by Dunod, Paris. Written in French. Reviewed in *Chaleur ind.*, **10**, 515 (1929). A.J.M.

Commercial Chromium Plating. RICHARD SCHNEIDEWIND. Univ. of Mich. Circular Series No. 3. Price 50¢. A description of the design of chromium-plating equipment and the mechanism of chromium deposition is given, pointing out common

defects. Reviewed in *Can. Chem. Met.*, **14** [2], 56 (1930); see also *Ceram. Abs.*, **8** [4], 289 (1929). E.J.V.

PATENTS

Tile-cutting machine. OTTO WALTER. U. S. 1,750,737, March 18, 1930. A machine for cutting tile, etc., having a stationary frame, a water tank mounted therein with its top open, a vertically disposed rotary cutter having its periphery formed of emery, etc., and mounted in the machine so that the lower portion thereof will run in the water in the tank and the upper portion thereof will extend above the tank, an upper portion of the frame including a table which portion is hinged at the rear end to the stationary portion of the frame and arranged so that the front end thereof may be lifted and tilted upward and backward, and the table thereof being provided with a slot through which the upper part of the cutter projects, and a water deflector secured at the rear end of the upper part of the frame and extending forward and free above the cutter with the sides and front end thereof extending below the upper edge of the cutter for concentrating the water which is thrown upward against the reflector down on the cutter, substantially as set forth.

Automatic means for turning and finishing ware in manufacture of pottery. WILLIAM J. MILLER. U. S. 1,751,049, March 18, 1930. In mechanism of the class specified, in combination, a fluid-operated ware pick-up device, means for moving the latter in a predetermined path, of a ware-turning and finishing assembly including rotating cutting and burnishing tools, and a pattern device mounted adjacent the pick-up device for automatically guiding the tools.

Drying system. J. PÖSSNER. Brit. 321,921, Jan. 15, 1930. A kiln suitable for drying brick, timber, etc., is constructed with a pair of parallel walls which are preferably circular so that the kiln is annular, and is subdivided into a number of compartments by transverse walls which do not extend completely across the kiln. Fans and heaters are arranged in alternate compartments and maintain a large local circulation of air with a minor zig-zag transference. The main walls of the kiln consist substantially of hinged flaps which can be opened at suitable points for charging and discharging the material and for admitting and exhausting air. Additional heated air may be admitted to any compartment from an underground channel. (*B.C.A.*)

Kilns, Furnaces, Fuels, and Combustion

New type of laboratory furnace. CHARLES MCMULLEN. *Eng. Mining Jour.*, **129** [4], 200 (1930); see *Ceram. Abs.*, **9** [3], 191 (1930). E.C.C.

Automatic fuel feeding by stoker. ANON. *Brick Clay Rec.*, **76** [5], 320 (1930).—The stoker installation on the Dressler tunnel kiln at the Harbison-Walker Refractories Co.'s plant at Templeton, Pa., is an interesting method of mechanical fuel feeding which insures an even temperature range and permits the use of cheaper coal. The stokers are of the usual underfeed screw type, especially fitted for easy removal of clinkers and ashes. The operation of the stokers is described. The kiln is equipped with 12 stokers, 6 on each side, and approximately 38,000 fire brick, fired at a temperature of cone 14, are run through the kiln every day. One of the most important advantages carried with this installation is said to be that the coal is fed more regularly and the temperature can be maintained to a closer degree than with hand firing. Inasmuch as there is a continuous feed of green coal in the stokers there is a more uniform flow of gaseous hydrocarbon from the coal, making it easier to maintain a reducing condition in the kiln proper and to flash brick successfully throughout the entire load. Illustrated. E.J.V.

Babcock and Wilcox Co. announces new gas-fired laboratory furnace. ANON. *Amer. Glass Rev.*, **49** [20], 21–22 (1930); *Can. Chem. Met.*, **14** [3], 41 (1930); *Ceram. Ind.*, **14** [3], 332 (1930); for abstract see *Ceram. Abs.*, **9** [3], 191 (1930). E.P.R.

Electric heat-treating furnaces. A. H. VAUGHAN. *Iron Age*, **125**, [5] 357–61 (1930).—Describes types of furnaces used for steel and nonferrous metals and discusses problems in their design. The largest electric heat-treating furnace ever built is illustrated. E.C.C.

Résumé of advances made in downdraft kiln design and operation in past five years. A. F. GREAVES-WALKER. *Clay-Worker*, **93** [3], 205–206 (1930).—Under advances in kiln design are included forced and induced draft, stokers, kiln bottom design, crowns for rectangular kilns, sewer pipe kilns, and carboradiant kiln; while under firing practice advances include use of fuel oil; investigations of the correct specific heat of clays; use of manufactured or city gas or powdered coal; smoke prevention; heat-balance determinations; and low temperature oxidation. Use of manganese for coloring, and insulation of kilns are also discussed. E.J.V.

Controlling firing in annular kilns. K. O. SCHULTZ. *Tonind.-Ztg.*, **53** [98], 1721–22 (1929).—Two most important factors for an economical operation of an annular kiln are (1) regulating the surplus air in the fire space by proper adjustment of the flue; (2) regulating the draft for drawing off hot air behind the fire. S. states that the velocity of a current of gas or air varies inversely with the size of the apertures through which it passes; or, the larger the apertures, the slower the velocity of the air currents. Thus, the narrower the spaces between the ware in the kiln, the sharper the draft and the hotter the fire. This active combustion may bring about injuries to the ware. M.V.K.

Repairing kiln linings. ANON. *Brit. Clayworker*, **38** [454], 411–12 (1930).—If the defects in the kiln lining are very serious it may be necessary to reline the kiln, but much may be done in many kilns by filling cracks in the brickwork and applying a coating of suitable material to the surface. The lining should be built of fire brick rich in grog and laid with the thinnest possible joints. A mixture of clay and moderately coarse grog is usually the most satisfactory material. Many attempts have been made to cause such cements to flux easily, but most of them have failed. The most satisfactory method is by means of a spray applied through a white-washing machine or "cement gun." Sprayed material adheres better than that laid on with a trowel or brush. The range of composition of satisfactory cements for spraying appears to be rather limited. R.A.H.

Periodic, half-continuous, and continuous kilns for refractory materials. ANON. *Brit. Clayworker*, **38** [451], 299–308 (1929); *Tonind.-Ztg.*, **53** [101], 1781 (1929); for abstract see *Ceram. Abs.*, **8** [2], 142 (1929). M.V.K.

Firing salt-glazed pipes. ANON. *Brit. Clayworker*, **38** [454], 407–409 (1930).—Some precautions and suggestions are given relative to the successful firing and salting of pipes both in single and continuous kilns. Two figures are given. One shows the normal rise of temperature in the kiln in relation to the time of firing, the slow rise during 32 hours of "drying off," the quicker rise during 32 to 64 hours, and the still more rapid rise up to the sintering point which occurs 80 hours after firing is begun. The fall of temperature after each salting is clearly shown in the 80- to 84-hour period as is also the final heating to insure a good gloss. The second figure shows (*a*) the time required to raise pipes of different sizes satisfactorily to 200°C (end of drying-off stage). Few firemen realize how much longer time is required for drying large pipes. (*b*) The same figure also shows the time required to complete the firing of pipes of various sizes. It shows that pipes 28 in. in diam. require just twice as long a firing time as those 13 in. in diam. R.A.H.

New laboratory oven. ANON. *Can. Chem. Met.*, **14** [3], 41 (1930).—The Freas Thermo Electric Co. has announced a new series of controlled-heat electric laboratory ovens with horizontal flow forced air circulation. The new oven permits the use of shelves and trays without obstructing air circulation. It is designed to give greater speed in baking and drying operations under controlled heat. The general construction of the new oven is similar to other Freas laboratory ovens. The framework is of welded structural steel. Double walls of high thermal resistivity furnish the insulation. Heaters are nickel chromium alloy. The intake and exhaust in air are controlled by means of adjustable shutters on the vent and air ports. E.J.V.

Auxiliary furnace for thermal elaboration of glass. A. TSIPEROVICH. *Ceramics and Glass* [Moscow], **5** [5], 177 (1929).—The problem of construction of a small and compact furnace in which a high pyrometric effect can be obtained with an economical use of fuel has been solved by T. based on the following principles: (1) heating of air and gas by means of a recuperator; (2) increasing the heat of gases entering the furnace (*a*) by making the walls of the recuperator thin, (*b*) by enlarging the heating surface, (*c*) by increasing the velocity of gases in the channels of the recuperator and (*d*) by conducting heated and cooled gases according to the principle of counter-currents; (3) directing heated gases upward and cooled gases downward; (4) increasing the pyrometric effect by careful mixing of heated air and gas; and (5) burning of fuel of all kinds, such as hard, liquid, and gaseous. A description of the furnace is given. W.A.

New muffle kiln. ANON. *Brick Clay Rec.*, **76** [5], 334 (1930).—Richard C. Remmey Son Co., Philadelphia, Pa., announces a new block and tile muffle furnace. The clay blocks which are supports enable very thin tile to be used. Thin tile radiate heat more rapidly than thick ones, and cost less. In this furnace, the tile are made of Remmey semisilicon carbide, which radiates the heat much more rapidly than clay tile. The floor tile are also made of semisilicon carbide and are much thinner, stronger, and have more conductivity than ordinary floor tile. E.J.V.

Laclede-Christy adding tunnel kiln. ANON. *Brick Clay Rec.*, **76** [5], 305 (1930).—A second tunnel kiln of the Russell type, which will increase the capacity by 30 to 35 M 9-inch equivalents per day, making the total capacity of the St. Louis plants 75,000 M 9-inch equivalents, is being installed at the plant of the Laclede-Christy Clay Products Co., at an approximate cost of $250,000. E.J.V.

Heating industrial furnaces with coke-oven gas and distribution of such gas at a distance. A. LEMONNIER. *Chaleur ind.*, **10,** 381–84 (1929). A.J.M.

Our fuel industry. ANON. *Mining Jour.*, **168** [4929], 96 (1930).—A discussion of the fuel situation in Great Britain. E.C.C.

Oil fuel and the brick industry. I. LUBBOCK. *Brit. Clayworker*, **38** [454], 431–32 (1930).—Because of the general downward trend of oil prices, fuel oil is brought within a measurable distance of equality with coal for the firing of kilns used in the brick industry. On the direct fuel cost alone for firing so many thousand brick, the latest results still indicate that the firing cost itself is somewhat higher than with coal. Against this, however, must be set the following advantages: (1) the time of firing can be reduced; (2) the number of underfired brick can be almost entirely eliminated; (3) there is a saving in labor for coal and ash handling. Any one of the 5 following types of burners can be utilized for burning oil: (1) pressure jet or mechanical atomization; (2) low-pressure air; (3) medium-pressure air; (4) high-pressure air or steam; (5) centrifugal atomizers with spinning cups, either mechanically blown or air blown. The report gives results obtained in a tunnel kiln as well as intermittent kilns with oil vs. coal firing. A brief discussion is given on the drying of brick when fuel oil is used for heating tunnel driers. R.A.H.

Economics of producer gas, fuel oil, and natural gas compared. IV. JOHN W. ROMIG. *Glass Ind.*, **11** [3], 62–63 (1930).—In making the analyses of natural gas as tank fuel, calculations are developed which are applicable to butane, oil still, blue and water gas, providing that proper analytical values and data are substituted for corresponding items indicated. In the case of natural gas it is impracticable to preheat the gas in checker chambers because hydrocarbons tend to break down and there is danger of explosions. Full details of the method used in making the calculations involved in making an analysis of natural gas as a tank fuel are given. See also *Ceram. Abs.*, **9** [4], 303 (1930). E.J.V.

Artificial petroleum. W. IPATIEFF. *Chaleur ind.*, **10,** 377–79 (1929). A.J.M.

Laws of thermochemistry and calculation of calorific power. M. VERON. *Chaleur ind.*, **10,** 433–38 (1929).—V. discusses the laws of thermochemistry and reviews the various formulas which have been proposed for calculating the calorific powers of fuels. A.J.M.

Gas as fuel for clay plants. ANON. *Brick Clay Rec.*, **76** [5], 321 (1930).—About 120 plants in the clay industry are employing gas at the present time. The development of continuous kilns presents the big opportunity for fuel-gas development. The tunnel kiln is an economical user of fuel permitting more accurate control of firing, and gas is an ideal fuel where cost is not excessive. Gaseous fuels are clean and easy to control. E. J. Lavino & Co. fires its tunnel kiln with city gas, with a maximum temperature of 2800°F in a firing zone 123 feet long. Several other manufacturers are using gas with good results. E.J.V.

Long-distance gas transmission. ANON. *Times Eng.* [Supp.], **25,** 281 (1929).—The Ruhr Gas Co., situated on the coal-field, is extending its system of pipe-lines far into the north and south of Germany. Transmission of gas by long distance is claimed to be considerably cheaper than rail transport of coal. H.H.S.

Technical investigation of the effect of heat inside a fuel oil porcelain hearth. J. V. GELFENBEIN. *Ceramics and Glass* [Moscow], **5** [5], 180–83 (1929).—The real effect of heat inside furnaces commonly used is insufficiently known; therefore a detailed study of this effect should be made in a given furnace in order to establish its weak points. G. presents figures and tables in connection with the study of questions asked by him under the following headings: (1) description of the hearth itself, (2) fuel, (3) materials under investigation, (4) results of observation, (5) velocities of gases inside the hearth, (6) process of firing, (7) coefficient of utilization of heat in the first floor of the furnace, and (8) cooling of the hearth. W.A.

Thermodynamics of pulverized fuel firing. P. ROSIN. *Z. Ver. deut. Ing.*, **73,** 719–25 (1929).—A paper read before the Second International Conference on Bituminous Coals at Pittsburgh. The investigation of the thermal principles shows that firing by pulverized fuel is essentially a problem of velocity. The duration of combustion, the rate of firing, the dimensions of the furnace, and the gas velocity are definitely interrelated, and attention must be given to these points in the construction of a furnace. Theoretically, the rate of firing is inversely proportional to the size of the furnace and to the duration of combustion, and the latter itself is a complicated function of the fineness of the powdered fuel, of the temperature, and of the aero-dynamic properties of the furnace; the rate of firing is dependent on the rapidity of the transfer of heat to the heating surfaces. (*J.I.S.I.*)

Arrangement of furnaces for combustion of pulverized fuel. JULES DESCHAMPS. *Rev. de l'Industrie Minérale*, Memoires, pp. 361–66 (1929); *Chaleur ind.*, **10,** 512 (1929).—Various methods of firing, gas, pulverized fuel, lump coal, etc., are compared. The combustion of pulverized fuel is discussed, and the advantages and disadvantages of the use of pulverized fuel in various types of furnaces (industrial, boiler, etc.) are dealt

with. The interior arrangement of boiler furnaces and the protection of the walls, etc., are discussed; protection by means of ribbed water-tubes which will catch a small amount of ash is suggested. See also *Ceram. Abs.*, **9** [3], 225 (1930). (*J.I.S.I.*)

Utilization of national combustibles in Italy. A. PELLACINI. *Corriere ceram.*, **10** [6], 213–15 (1929).—P. gives the possibilities for increasing and making more practicable the use of the xiloid lignite, which with pinaster lignite, forms the only national source of combustible for industry in Italy. M.V.K.

Liquid combustibles. ANON. *Corriere ceram.*, **10** [6], 229–33 (1929).—Four different systems for using heavy oils for fuel in ceramic industries are described and compared. They are (1) pressure system which is universally employed in the navy and has the advantage of using less steam for heating and atomizing the oil; (2) a system using the jet of steam to atomize the oil; (3) compressed air system; (4) low air-pressure system in which the air converts the oil into fine droplets in a cone-shaped jet as in an aerograph. This system seems to give the greatest satisfaction. M.V.K.

Ignition temperatures of gaseous combustible mixtures. M. PRETTRE AND P. LAFFITTE. *Annales de l'Office national des combustibles liquides*, May-June, 1929. A.J.M.

Blending gases to compensate for specific gravity changes. R. B. STITZER AND K. M. WADDELL. *Gas-Age Rec.*, **65** [10], 319–22 (1930).—Changing conditions in the gas industry are rapidly introducing a number of problems which materialize at the burner. This paper refers particularly to the quality of the gas and to the specific gravity. From by-product coke-oven gas to carbureted water gas to natural gas there is a variation in physical characteristics which is fatal to burner adjustments and intolerable to the man who is paying for the gas. The operator who is trying to meet today's demand and avail himself of these gases or any of the other sources of supply is by no means certain how he is going to work it out. The general problem led to a study of the factors which cause such interference in burner operation, in an effort to modify or control the effect and eliminate disturbance. The result of the investigation points to a relatively simple and inexpensive method by means of which it is possible to effect complete interchangeability of fuel gases without the necessity for burner adjustment and without the least sacrifice of burner efficiency. This method is based on the blending of air or other gas with the fuel gas in certain definite proportions before the burner orifice. F.P.H.

BOOKS

Industrial Furnace Technique. A. HERMANSEN. Ernst Benn, Ltd., London, 1929. Reviewed in *Mining and Met.*, **11** [279], 38 (1930).—H., a well-known Swedish designer and manufacturer of industrial furnaces, has long been engaged in developing the mathematical and physical theory of the furnace, so as to place furnace design on a firm scientific basis. This book, of unusual interest to every designer, presents his conclusions concerning the conditions and calculations to be taken into consideration for different furnace constructions. Temperature, heat quality, combustion, the production of high temperatures, fuel transmission, and the movement of gases are discussed theoretically and in relation to furnace design, in the first half of the book. Furnace-building in general is then discussed, after which chapters are devoted to regenerators and recuperators, burners and draft openings, work chambers, calculation of the laboratory working space, furnace materials, supports, starting furnaces, and heat balance. Many useful formulas are given. F.P.H.

Industrial Heat Transfer. A. SCHACK. Reviewed in *Blast Fur. Steel Plant*, **18** [2], 312 (1930); see also *Ceram. Abs.*, **9** [4], 313 (1930). F.P.H.

PATENTS

Tunnel kiln. FRANCIS A. J. FITZGERALD AND JAMES KELLEHER. U. S. 1,749,762, March 11, 1930. In an electric kiln furnace, a chamber through which material to be heated to a high temperature is moved, a resistor exposed to the atmosphere of the chamber and adapted to heat such material to a temperature less than the high temperature, and an enclosed resistor adapted to heat the material from the second-named temperature to the high temperature.

Continuous kiln. CHARLES BURTON WINZER. U. S. 1,749,866, March 11, 1930. In a continuous kiln, the combination of an annular rotary tunnel having a combined loading and discharge opening in its outer wall; driving means for the tunnel; means for heating the interior of the tunnel; an upper and a lower stationary annular platform enclosed in superposed relation within the confines of the tunnel, the upper platform embodying a circular series of sections capable of individual movement radially through the opening; an annular track encircling the tunnel in proximity to its outer wall; and a platform mounted opposite the opening to travel with the tunnel along the track, each section of the upper platform adapted to support a removable goods carrier which is withdrawn with the corresponding section through the opening onto the traveling platform.

Terra cotta firing system. ALBERT H. SHEFFIELD. U. S. 1,749,988, March 11, 1930. In a terra cotta firing system, a kiln having a continuous side wall, and an entirely closed bottom, a relatively low bag wall extending around the inside of the kiln to form a continuous space between the side wall and bag wall, a continuous bottom between the side wall and bag wall substantially in the plane of the bottom of the kiln and a plurality of openings extending through the side wall and communicating with the continuous space.

Calcining furnace. ERNST KLÖHN. U. S. 1,751,161, March 18, 1930. A circular muffle calcining furnace, comprising an annular hearth having an inner circumferential wall formed with a continuous circumferential slot, heating means for the hearth, stirrer arms projecting through the annular slot from the median part of the furnace into the hearth, a ring carried by the stirrer arms in position for covering the slot, packing members fixed to the circumferential wall and coöperating with the ring for closing the slot, and means for rotating the stirrer arms.

Furnace for refractory materials. SOC. DES MINES DE LENS. Fr. 667,297, Jan. 12, 1929. (*C.A.*)

Mechanical coal feed for annular kilns. HARRY KLOSTERMEYER AND ALBERT KLOSTERMEYER. Ger. 467,458, Aug. 14, 1927. Constructional details. (*C.A.*)

Coal-supplying means for annular kilns. HARRY KLOSTERMEYER AND ALBERT KLOSTERMEYER. Ger. 484,642, Dec. 9, 1928. Addition to above abstract. (*C.A.*)

Kilns. INGENIEUR GAIRING MASCHINENFABRIK. G.M.B.H. Ger. 485,980, May 16, 1928. Details of charging with fuel. (*C.A.*)

Brick kiln. ALOIS HABLA. Ger. 485,975, Oct. 27, 1927. Details of construction and arrangement are given. (*C.A.*)

Tunnel kiln for ceramic ware. BARTON FOREIGN PATENTS, LTD. Ger. 485,976, Jan. 29, 1928. Details of construction and operation are given. (*C.A.*)

Process and apparatus for carbonizing bituminous substances. ANON. Ger. 476,660, Dec. 17, 1926; *Gas-Age Rec.*, **65** [8], 256 (1930).—The apparatus in which the process is carried out is heated both internally and externally. The current of heating gases is divided. The smaller part of the latter is passed through the charge of bituminous substance toward the end of the carbonization period in counter-current to the flow of the fuel. The remainder of the heating gases are passed through a cylinder

apparatus in the same direction as the flow of charge through this apparatus, so that the coal is preliminarily dried before carbonization. F.P.H.

Operating chamber ovens for production of gas and coke. ANON. Ger. 476,512, Aug. 3, 1927; *Gas-Age Rec.*, **65** [8], 256 (1930).—A layer of material such as coke, which is unresistant to the passage of gas, is arranged on the bottom of the oven chamber. This layer of coke is connected with pressure equalizing conduits spaced between the doors and the door frames, so that the distillation gases, which are produced in the lower part of the horizontal oven chamber, without coming into contact with the charge in the chamber or the walls of the chambers, can be conducted away with the aid of the pressure-equalizing conduits into the gas-collecting space located above the chamber charge. F.P.H.

Geology

The kaolin minerals. CLARENCE S. ROSS AND PAUL F. KERR. *Jour. Amer. Ceram. Soc.*, **13** [3], 151–60 (1930).—A report of an investigation of clay minerals, nacrite, dickite, and kaolinite is presented in which the methods of study are explained. The optical and physical properties, chemical composition, and X-ray studies of these kaolin minerals are discussed and the results of the study are outlined.

Dickite, a kaolin mineral. CLARENCE S. ROSS AND PAUL F. KERR. *Amer. Mineralogist*, **15** [1], 34–39 (1930); see *Jour. Amer. Ceram. Soc.*, **13** [3], 151–60 (1930). F.P.H.

Hydrates of sodium carbonate. ADOLF PABST. *Amer. Mineralogist*, **15** [2], 69–73 (1930).—Sodium carbonate forms at least three stable hydrates, the mono-, hepta-, and deca-hydrates. Besides these there have been described a large number of other hydrates which are probably unstable. The existence of these other hydrates has been called into question by various writers. In the course of some work on the system Na_2CO_3–K_2CO_3–H_2O, P. obtained several hydrates of sodium carbonate and is able to affirm definitely the existence of the hemipentahydrate $Na_2CO_3\ 2^1/_2\ H_2O$. Several observations agree in indicating the existence of the hemipentahydrate of sodium carbonate as a phase quite distinct from the monohydrate, thermonatrite. These are (1) analyses of the material, (2) crystallographic data which are characteristic, (3) optical data which enable its recognition, (4) density determination in agreement with calculated value, and (5) relation of density to densities of related hydrates in agreement with expectation. F.P.H.

Translation-gliding in crystals. M. J. BUERGER. *Amer. Mineralogist*, **15** [2], 45–64 (1930).—The plastic deformation of crystals appears to be of very remote interest to most crystallographers and mineralogists. The crystallographic investigations along this line have been carried on mainly by our more academic German contemporaries, especially by Mugge and Johnsen. On the other hand the metallurgists have deluged their literature with a large mass of data, accompanied by encouraging crystal structure explanations, bearing on the plastic deformation of metal crystals. While this branch of crystallographic metallurgy is still in its infancy, enough evidence has been brought forward to demonstrate that the plastic properties of metals are dependent upon, and to a remarkable degree, predictable from their respective crystal structures. In the absence of any treatment of translation-gliding in English, B. presents an introduction to forthcoming experimental and theoretical contributions to the knowledge of that subject. The fundamental concepts are discussed, and a tabulation of existing data and literature appended. F.P.H.

Fusion relations of acmite. N. L. BOWEN AND J. F. SCHAIRER. *Amer. Jour. Sci.*, **18** [107], 365–74 (1929).—Acme is found to melt incongruently with separation

of hematite and its melting or crystallization, with perfect equilibrium, can be expressed in terms of the join $Na_2O \cdot 4SiO_2 \cdot Fe_2O_3$. The results of investigation of this join are presented. This investigation shows that the incongruent melting of acmite occurs at 990°, hematite separating and the liquid having the composition $Na_2O \cdot 4SiO_2$ 71.5, Fe_2O_3 28.5, acmite itself having 34.5% Fe_2O_3. The temperature must then be raised to about 1275° (nearly 300°) before complete solution of hematite occurs. Crystallization of liquid of the composition of acmite is, with perfect equilibrium, the reverse of the above. Hematite reacts with liquid at 990° to produce acmite. If the reaction is incomplete some liquid remains in excess. Upon lowering of temperature, acmite separates from this liquid, and at 850° it is joined by quartz, which forms sharp bipyramids analogous to the phenocrysts of many rhyolites. With further cooling the crystallization passes into the ternary system and is complete only at the ternary eutectic acmite-quartz-sodium disilicate. It is suggested that the excess of sodium silicate in many rocks bearing acmite and related sodic amphiboles is the result of crystal fractionation of the above type, controlled by the incongruent melting of acmite.

F.P.H.

The system: leucite–diopside. N. L. BOWEN AND J. F. SCHAIRER. *Amer. Jour. Sci.*, **18** [106], 301–12 (1929).—The system, leucite–diopside, is of the simple eutectic type. Leucite ($KAlSi_2O_6$) melts at 1686 ± 5° and diopside ($CaMgSi_2O_6$) melts at 139.5°. The eutectic is at 61.5% diopside and the temperature is 1300 ± 2°. Both the liquidus of leucite and that of diopside have the unusual form of reversed curves. Mixtures of leucite and diopside may be regarded as the simplest possible leucitites. Natural leucitites are much more complex and will be completely liquid at considerably lower temperatures. They will, moreover, in virtue of a notable content of Na_2O, partake somewhat of the complex reaction relations exhibited in diopside-nephelite mixtures. The inversion of leucite and consequent straining of the crystals may be a material aid to the thorough transformation of leucite to that intergrowth of orthoclase and nephelite known as pseudo-leucite.

F.P.H.

Analcite and meerschaum beds. W. H. BRADLEY. Government Printing Office, Washington, 1929. U. S. Geol. Surv., *Prof. Paper*, No. 158A.—The occurrence and origin of analcite and meerschaum beds have been located in the Green River formation of Utah, Colo., and Wyo.

H.H.S.

Application of X-rays in classification of fibrous silicate minerals commonly termed asbestos. H. V. ANDERSON AND G. L. CLARK. *Ind. Eng. Chem.*, **21** [10], 924–33 (1929).

R.G.M.

Barite and barium products. I. General information. R. M. SANTMYERS. Bur. Mines, *Information Circ.*, No. 6221, 55 pp. (1930).—The element barium occurs in nature as the minerals barite and witherite. The chemical compounds manufactured from these two minerals constitute an important class of commercial products, the use of which in certain cases has been increasing steadily during recent years. The report goes into considerable detail relative to barite and barium products on the following points: description and uses, history, mode of occurrence, geographical distribution, description of domestic deposits in Mo., Ga., Tenn., Va., S. C., N. C., Conn., and Ky., mining methods, washing and milling, world's production, domestic production, imports, consumption, prices, tariff history, and barite in foreign countries, such as Germany, Great Britain, Italy, and Canada.

R.A.H.

New uses for bismuth. ANON. Bur. Stand., *Tech. News Bull.*, No. 154, p. 13 (1930).—An important project under way in the metallurgical division of the Bureau at the present time is a search for new and wider uses for bismuth. The potential supply of this metal far exceeds the present demands. It does not appear from the work done so far that wider uses for bismuth are to be found by substituting it for ma-

terials already in use. Utilization of some of the unique properties of the metal will undoubtedly be found to be the answer. R.A.H.

U. S. imports of chrome ore in 1929. DONALD P. LLOYD. *Commerce Repts.*, **9**, 599–600 (1930).—Imports of chrome ores into the U.S. in 1929 were 101,038 T. more than in 1928. This amount represents an increase of 46.7% and indicates a sharp upturn in the growing demand for chromium which has been evidenced particularly since 1922. Wider use of chromium plating, larger production of chrome-alloy steels, and a considerable increase in the sales of chrome refractories and chemicals, all contributed toward the advance. Preliminary statistics of production in some of the leading chrome-producing countries indicate that there was a considerable increase in the total world output in 1929. E.J.V.

Domestic chrome mining. W. P. LASS. *Eng. Mining Jour.*, **129** [2], 77–78 (1930).—Chromite is found on Kenai Peninsula, Alaska, at Chain Point and Red Mountain. The outstanding feature of these deposits is their continuity for considerable distances in bands or layers, for such bodies elsewhere are generally scattered and pockety. The Red Mountain shipping ore analyzes over 50% Cr_2O_3 and the deposit contains 90,000 T. of shipping ore and 80,000 T. of lower-grade ore. The Chain Point deposits contain 10,000 T. of shipping ore and 60,000 T. concentrating ore. The average concentrate yields 50% Cr_2O_3. The iron content is 10 to 14%. E.C.C.

Chromite mining development in Canada. ANON. *Eng. Mining Jour.*, **168** [4927], 64 (1930).—The Consolidated Chromium Corp. of New York plans to develop the rich chromium deposits in the Lake Nipigon region of Northern Ontario. E.C.C.

Chromium ore investigated. ANON. *Can. Chem. Met.*, **14** [3], 36 (1930).—The deposits of chromium at Obonga Lake, in northwestern Ontario, are being investigated. Samples show analyses of the order of chromic oxide 31.0%, iron oxide 22.0%. Chromium has been known in the region for some time. The rough geology of the deposit indicates considerable chromite along the foot-wall side of a dike-line mass of basic rock, several thousand feet long. It is stated that on the foot wall along the zone of the dyke's greatest width, the accumulation of chromite has been sufficient to create deposits running from 8 to 17% Cr_2O_4. A series of massive chromite veins from 10 in. to 2 ft. in width has been found at some distance from the contact. These run 34% Cr_2O_3 with a favorable ratio of iron. World chromite reserves are limited, and increasing consumption warrants the investigation of this deposit. E.J.V.

Developing the nonmetallic industries of the West. WALTER W. BRADLEY. *Pit and Quarry*, **19** [12], 58–60 (1930).—B. gives a comprehensive listing of the nonmetallic minerals of the states. E.P.R.

Dumortierite in California. F. MACMURPHY. *Amer. Mineralogist*, **15** [2], 79–80 (1930).—An occurrence of dumortierite is in the vicinity of the Cajalco tin mine approximately 13 miles southwest of Riverside, Calif. Apparently the mineral is widespread in the region, as suggested by a specimen collected by Charles Anderson from a point four miles northwest of Corona. The dumortierite occurs in a granodiorite country rock whose chief constituents in apparent order of abundance are orthoclase, oligoclase, quartz, and biotite. The rock is hypidiomorphic granular, coarse-textured, and rich in quartz. Accessory minerals are titanite, magnetite, and apatite. The rock generally carries more or less tourmaline especially near each of the numerous well-defined tin-bearing tourmaline-quartz veins on the property. F.P.H.

Feldspar producers meet changing demands. E. W. KOENIG. *Glass Ind.*, **11** [3], 65 (1930).—The need of the feldspar consumer is uniformity. No feldspar in its natural occurrence is entirely uniform in commercial quantities. Feldspars from the same mine vary in chemical composition due principally to variations in the percentage of free quartz. By removing most of the free quartz, by proper concentrating methods,

the feldspar from the same mine tends toward greater uniformity, both chemically and mineralogically. It is an accepted fact that ores originating in the same deposit have the same mineralogical composition which is desired by all consumers of this commodity, and that feldspars of like chemical composition, as shown by chemical analysis may be totally unlike mineralogically. A series of processes designated as "uniformity control" are constantly being improved. It is essential, if a constant material is to be produced, that an intelligent coördination of all the means contributing to uniformity be exercised. Each has its place, dependable deposit, selection, mechanical handling at each step, chemistry, grinding, and loading, but the ultimate is not achieved until all are combined to the best advantage. This accuracy of uniformity control permits grouping feldspars under various classifications, on bases indicated by the particular requirements of the industry to be served. Chemical control, if properly handled, gives an accurate index of the chemical composition of the product under consideration, but nothing more. It tells nothing of the mineralogical composition or the physical functions of the material, nor does it guarantee that in its use by the manufacturer it will perform exactly the same as another quantity of like chemical composition but originating in different deposits. Melting point, fluxing behavior, firing range, contraction, and expansion, are characteristics of feldspar determined by the mineralogical constitution (the proportions in which the different types of feldspar occur) and by the eutectics of the feldspar. The mineralogical composition of feldspars determines the eutectic properties and controls the firing range. Variations in mineralogical composition cannot be determined by chemical analysis and the eutectics and the firing range will not remain uniform, making it necessary for the batch to be altered frequently.

E.J.V.

Commercial standard for feldspar proposed. ANON. *Pit and Quarry*, **19** [8], 65 (1930); *ibid.*, **19** [10], 61–62 (1930); see *Bull. Amer. Ceram. Soc.*, **9** [2], 47–48 (1930).

E.P.R.

Feldspar development in North Carolina. I. B. C. BURGESS. *Glass Ind.*, **11** [3], 58–61 (1930).—To improve the condition of the feldspar industry and eliminate many of its former ills several remedies have been applied. About 80% of the feldspar business has been consolidated into the hands of the four largest producers, overdevelopment has been reduced from 400% to about 200%, new equipment has largely replaced that in use in 1919, producers and consumers are bringing their plants under chemical control, and the Feldspar Grinders' Institute has been formed primarily for the purpose of studying the industry and is already taking steps to place it on a still sounder basis. One of the notable factors in this revolutionary development during the past 8 years has been the establishment of a modern grinding plant by the Tennessee Mineral Products Co. in N. C., a locality formerly in bad repute as a source of dependable feldspar. The early mining efforts and research of the company disclosed to them that the pegmatite dykes from which feldspar can be commercially recovered are generally conformable with the stratification of the schists and gneisses enclosing them, and that the occurrence of feldspar with respect to these dykes is in one of three ways: (1) occupying the larger part of the pegmatite and conforming with it in strike and dip; (2) as a cross dyke or fissure filling occurring at or near right angles with the strike and dip of the pegmatite enclosing it; (3) as hit-and-miss occurrences in varying sizes scattered irregularly through the parent dyke of pegmatite. The characteristic features of each of these three occurrences are enumerated. North Carolina deposits are of all three types, with frequent combinations of two or more showing why there was much trouble from lack of uniformity. Study of the problem indicated that a conical mill in closed circuit with a centrifugal separator was the most efficient fine grinding equipment and a small single unit plant was built at Bristol, Tenn., in 1923 to gain practical

experience in grinding and supplying the trade. Production from this pilot operation disclosed various process features and methods of general metallurgical use which were adaptable to feldspar grinding. As the trade began to appreciate uniform quality and the analytical service, which had been inaugurated shortly after a laboratory was completed, business increased to such an extent that the larger plant was built at Spruce Pine. Illustrated. E.J.V.

Varieties and occurrence of feldspar. ANON. *Pit and Quarry*, **19** [10], 62 (1930).—Feldspar is a general name for a group of rock-forming minerals of varying composition. The most important varieties from a commercial standpoint are orthoclase or potash feldspar, and microcline which has the same composition as orthoclase and differs only in crystal form; these varieties constitute the great bulk of the feldspar that finds commercial use. Albite or soda feldspar, anorthite or lime feldspar, and mixtures of these are used to some extent. Feldspar forms a considerable part of such common and widespread igneous rocks as granites, in which it occurs in grains varying in size. E.P.R.

Expansion of alkali feldspar on heating. SHUKUSUKE KÔZU AND KATSUTOSHI TAKANE. *Jour. Petrol. Mineral. and Ore Deposits* [Japan], **1**, 110–14 (1929).—For expansion measurement a specimen free from twinning must be chosen. According to K. and T.'s results obtained with an ordinary total dilatometer, a feldspar expands by about 2.2% at 1000° when it contains 10% of the Ab molecule. The rate of expansion increases with the content of Ab, the volume increase being 3.4% when the mineral contains 24% Ab. (*C.A.*)

Authigenic feldspar in limestone at Glens Falls, N. Y. JOSEPH T. SINGEWALD, JR., AND CHARLES MILTON. *Bull. Geol. Soc. Amer.*, **40**, 463–68 (1929).—The acid insoluble residue of the Trenton limestone contained crystals of feldspar, many showing well-defined outlines and twinning, mostly less than 0.05 mm. in length. The optical properties correspond to albite, but chemical analysis indicates a plagioclase feldspar (80 Ab 20 An). The rock is a low-mica, low-magnesium limestone, and contains abundant organic matter and some FeS_2. (*C.A.*)

New occurrences of authigenic potash feldspar. DORIS L. REYNOLDS. *Geol. Mag.*, **66**, 390–99 (1929).—Authigenic feldspar crystals were found in Triassic sandstone from Benbradagh Hill, northeast Ireland, the Keupen marl from Charnwood, a dolomite conglomerate from Wells, and a magnesia limestone from Roker. They are all related to the anorthoclase-microcline series. The crystals range from 0.004 to 0.03 mm. in length and are either rhomb-like or lath-shaped. A hydrothermal origin is indicated. (*C.A.*)

Indices of refraction of plagioclase feldspars. HAROLD L. ALLING. *Jour. Geol.*, **37**, 462–82 (1929).—A discussion of the accuracy of determining the composition of the plagioclase feldspars by means of the available curves of n. Consistent results are impossible due mainly to (1) inaccuracy of old chemical analyses used as a basis for the composition; (2) the persistent assumption that the plagioclase feldspars consist of 2, and only 2 end members. (*C.A.*)

Fullers' earth in 1928. JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources U. S.*, Part II, pp. 37–40 (1928).—The report discusses the output, value, occurrence, uses, history, production, and import and export of fullers' earth. R.A.H.

Gypsum in New Mexico. ANON. *Pit and Quarry*, **19** [12], 91 (1930).—Gypsum is found so generally distributed in New Mexico and occurs in such vast deposits and in such variety of forms that the supply is practically inexhaustible. The beds are thick and most of the material is exceptionally pure. E.P.R.

Heavy clay investigation. ANON. Bur. Stand., *Tech. News Bull.*, No. 154, p. 15 (1930).—Mineralogical examination of 27 Ohio heavy clays shows that they are very

impure, being composed of a large variety of minerals. Of the 3 groups, shales and glacial and alluvial clays, represented in this study, there are certain characteristics which are common to those clays in the same group by which it is possible to make a general summary. The average composition of the 12 shales is sand 27, silt 41, and clay 32%. The 8 alluvial clays show an average of sand of 19, silt 44, and clay 37%. The average composition of the glacial clays is sand 22, silt 53, and clay 25%. The sand separate contains the coarsest grains and more of them than the other types of clay. Other minerals are present in all of the clays in small amounts. R.A.H.

Chemical composition of kaolinite. KUNIKATSU SETO. *Jour. Petrol. Mineral. and Ore Deposits* [Japan], **1**, 179–81 (1929).—Analyses are given of material from (I) Baiji, Keishonando, Korea, (II) English china clay, (III) Atsushiomura, Fukushima Prefecture, (IV) Kamizawa, Gumma Prefecture, (V) Takatama Mine, Fukushima Prefecture. Column (VI) shows the theoretical composition.

	I	II	III	IV	V	VI
SiO_2	46.22	45.75	45.68	45.46	45.67	46.50
Al_2O_3	38.91	39.27	39.49	39.76	39.29	39.50
Fe_2O_3	0.38	0.29	0.59	0.67		
MgO	0.39	0.34	0.31		0.28	
CaO	0.62	0.35	0.74	0.29		
Na_2O	0.23	0.24	0.78	0.04	0.85	
K_2O	0.38	0.37	0.21	0.72	0.34	
TiO_2			0.97		0.16	
P_2O_5	0.08	0.59		0.21	0.09	
MnO			Trace		0.24	
H_2O	13.03	13.31	11.38	13.28	12.98	14.00
Total	100.24	100.51	100.15	100.43	99.90	100.00

(*C.A.*)

Magnesite as an industrial mineral. PAUL M. TYLER. *Can. Chem. Met.*, **14** [3], 38 (1930); for abstract see *Ceram. Abs.*, **8** [12], 896 (1929). E.J.V.

Manganese and tin in New Zealand. ANON. *N. Z. Official Yearbook*, **38**, 529–30 (1930).—Mn ore containing 56.5% Mn occurs at Waiheke Island near Auckland. Exports of Mn to the end of 1928 amounted to 19,385 T., valued at £62,006, Tin occurs in the South, on Stewart Island, as stream-tin and lode-tin; it is worked to a small extent. H.H.S.

Spanish tin, cobalt, and nickel discoveries. ANON. *Times Eng.* [Supp.], **25**, 274 (1929).—Discoveries of Sn, Co, and Ni of an extensive character, have been made in the Province of Vizcaya (Biscay) in northern Spain. There is a zone of considerable mineral wealth 30 miles long and 3 miles broad. H.H.S.

Thermal anomaly of the yellow orthoclase found in Madagascar. SHUKUSUKE KÔZU AND JUN'ICHI UYEDA. *Jour. Petrol. Mineral. and Ore Deposits* [Japan], **1**, 232–34 (1929).—The pure mineral has the chemical composition expressible by $K_2O \cdot Fe_2O_3 \cdot SiO_2$. According to K. and U.'s measurements it shows a negative expansion on heating, different from other minerals of similar kind. Thus, the linear thermal expansion in the direction $\perp$ (010) is -0.27% at 50°, -0.31% at 1000°. This, as well as the chemical composition, seems to be characteristic of the mineral. (*C.A.*)

Phosphate rock in New Zealand. ANON. *N. Z. Official Yearbook*, **38**, 535 (1930).—Considerable deposits occur in Otago province, and are being actively worked. A limestone containing 10.6% $Ca_3P_2O_8$ occurs in the Waikato district. H.H.S.

Prospect to develop deposits. H. J. BRYSON. *Pit and Quarry*, **19** [9], 85 (1930).—B. sees commercial possibilities in the development of vermiculites of N. C., with reports of extensive deposits from several counties. The common characteristics of all the vermiculites is the property of exfoliation; opening out into worm-like threads when heated. E.P.R.

Nonmetallic minerals. OLIVER BOWLES. *Eng. Mining Jour.*, **129** [3], 131–34 (1930).—Increased demand and technical improvements were outstanding developments in most of the nonmetallic industries in 1929. The economic conditions of the barytes, fluorspar, feldspar, gypsum, kaolin, magnesite, mica, phosphate rock, silica, soapstone, and talc industries in 1929 are discussed in detail. E.C.C.

Pacific coast nonmetallic minerals industry. GORDON F. SONDRAKER. *Pit and Quarry*, **19** [7], 42 (1930).—In the major nonmetallic products used in the construction field, such as cement, lime, plaster, crushed rock, sand, and gravel, excessive competition with consequent demoralized prices has made the year unsatisfactory from the producers' point of view. The nonmetallic products in use by the glass, ceramic, chemical, and similar industries have had a good year. In this classification are included feldspar, quartz, silica, silica-sand, and clays. The outlook for 1930 is not bright, due to substitutes being discovered for present nonmetallics in their respective fields. E.P.R.

India's mineral resources. EDWIN PASCOE. *Times Eng.* [Supp.], **25**, 224 (1929).—The Director of the Geol. Survey of India reports a regrettable decline in prospecting and private geological enterprises. Production of coal, lead, magnesite, mica, and gold decreased. Iron ore, manganese, and ilmenite increased in output. H.H.S.

Advanced mine rescue training. I. Mine gases and methods for their detection. J. J. FORBES AND G. W. GROVE. **II. Instructions in methods of sampling and in use of Bur. of Mines portable Orsat apparatus for analyzing mine gases.** W. P. YANT AND L. B. BERGER. These are the first two of a series of 4 circulars designed for use in a course of training that will prepare mine officials to organize men for rescue and recovery work. R.A.H.

BOOKS

Standard Book on Minerals. W. E. FORD AND E. S. DANA. John Wiley & Sons, Inc. Reviewed in *Pit and Quarry*, **19** [8], 65 (1930).—The book covers the subjects of crystallography, physical properties of minerals, and chemical, descriptive, and determinative mineralogy. Not only is it used as a college textbook, but it is a valuable reference book for every person who has interests in any of the mineral industries. E.P.R.

The Earth: Its Origin, History, and Physical Constitution. HAROLD JEFFREYS. 2nd ed., 358 pp., 3 plates, diagrams. Cambridge University Press, Cambridge, 1929. Price 20s. Reviewed in *Geographical Jour.*, **74**, 584–88 (1929). H.H.S.

Mineralogy. HENRY A. MIERS. 2nd ed., revised by H. L. Bowman. 678 pp. Macmillan & Co., London, 1929. Price 30s. H.H.S.

Canada's Mineral Resources. ELWOOD S. MOORE. 316 pp. Simpkin, Marshall & Co., London, 1929. Price one guinea. A textbook, amply provided with sketch-maps, by the Professor of Economic Geology at Toronto. H.H.S.

Geology and Minerals of Ontario. W. L. GOODWIN. Industrial and Educational Publishing Co., Quebec. Reviewed in *Mining and Met.*, **11** [279], 34 (1930).—Reference is made to commercial uses of the different minerals, and the usual mode of occurrence and origins of most of the minerals. An index map of the Province of Ontario gives the location and names of the various geological maps issued by the Ontario Department of Mines. F.P.H.

Diatomaceous Earth. ROBERT CALVERT. Chemical Catalog Co., Westman Publications, Ltd., Toronto. 250 pp. Price $5.00. C. has dealt with the subject following the natural order of properties, production, and uses. After outlining the present status of the industry, the various grades of diatomaceous earth are listed. One chapter deals with mining and preparation. All industrial and process uses, such as filtra-

tion, are developed in detail. Several chapters are devoted to the manufacture of brick and insulating composition. Reviewed in *Can. Chem. Met.*, **14** [3], 56 (1930). E.J.V.

Geology and Mineral Deposits of South-Eastern Alaska. A. F. BUDDINGTON AND T. CHAPIN. U. S. Geol. Surv., *Bull.*, No. 800. Government Printing Office, Washington, D. C., 1929. Price 85c. H.H.S.

PATENT

Complex silicates. FELIX SINGER. Ger. 487,012, July 8, 1927. Addn. to 486,218. The method of Ger. 486,218 is modified by including a Ti compound in the mixture. This addition acts catalytically and leads to the production of hexagonal minerals of the nepheline group. (*C.A.*)

Chemistry and Physics

Influence of chemical composition on the physical properties of glazes. F. P. HALL. *Jour. Amer. Ceram. Soc.*, **13** [3], 182–99 (1930).—This paper presents some preliminary work on the study of the factors affecting the fit of ceramic bodies and glazes. From the experimental work on 118 glazes and glasses, a method is outlined for calculating from the chemical composition of the glaze, approximate values of the tensile strength, Young's modulus of elasticity, and the mean linear coefficient of expansion of the glaze in the temperature range from 25°C to the lower limit of the critical range.

Iron oxide in borate beads. W. D. BANCROFT AND G. E. CUNNINGHAM. *Jour. Phys. Chem.*, **34** [1], 1–41 (1930).—Borate melts were made in porcelain crucibles, except with high alkali mixtures, when platinum was used. The color was determined by removing a drop on the end of a glass rod. Varying proportions of sodium, potassium, and lithium oxides were used with boric oxide. Calcium oxide was substituted for sodium in different proportions keeping soda and boric oxide constant at the optimum concentrations for these two taken alone. The theoretical discussion includes quotations from many sources with critical comments. The general conclusions of this study are (1) the blue color of iron compounds is due to an unstable modification of ferric oxide, which is stabilized by ferrous oxide, but to some extent by other substances. (2) In alkali borate melts, ferrous oxide is colorless, ferric oxide is yellow, and certain mixtures of ferrous oxide are blue. The greens are due to a mixture of the blue and yellow. (3) Using hydrogen as the reducing agent, the reduction of iron oxide to metallic iron takes place readily when the alkali concentration is low. (4) A slightly higher concentration of alkali prevents the formation of metallic iron, but does not favor the complete reduction of ferric to ferrous oxide, on account of the low solubility of the former and of the hydrogen. (5) A higher concentration of alkali checks the reduction to ferrous oxide. (6) When the ratio of ferrous oxide to ferric oxide reaches three in the borate glasses, most people call the glass free from green. When the same ratio reaches four or more, the blue becomes very beautiful. (7) It is easier to reduce ferric oxide in a potash boric acid bead than in a soda-boric acid bead; the best blues are obtained in the potash-borate glasses. (8) If any substance in the borate glass reacts with ferric oxide to form colorless ferrite, the glass will become bluer if all other variables remain the same. (9) From what we know about red chromium oxide in alumina and in glass, the ratio of ferrous oxide to ferric oxide necessary for a good blue may be quite different in a silicate glass from what it is in a borate glass. (10) The general principles which have been established for borate glasses are applicable also to fired clays and to iron-bearing minerals. G.R.S.

Optimum conditions for formation of silica gel from alkali silicate solutions. I. R. C. RAY AND P. B. GANGULY. *Jour. Phys. Chem.*, **34** [2], 352–59 (1930).—The formation of silica gel from alkali silicate solutions is influenced by a number of factors, such as temperature, stirring, light, but chiefly by the relative concentration of the silicate solution and of the solution used to produce the gel. Two solutions of alkali silicates, sodium and potassium, were prepared. Titrations with various acids were made and the results are given in tables and graphs. The p_H values corresponding to the points where gel formation just stopped were accurately measured. Results indicate that (1) the optimum conditions for the formation of silica gel by the action of HCl, H_2SO_4, and $FeCl_3$ on alkali silicate have been obtained. Hydrogen ion concentrations play a fundamental rôle in the process of gel formation. (2) For each concentration of the alkali silicate solution there is a limiting range of p_H values in which gel formation takes place. The region of gel formation has been accurately determined. (3) A convenient arrangement for producing silica gels from dilute silicate solutions has been described. (4) When H_2SO_4 is used the region of gel formation is not sharply demarcated. This has been found to be due mainly to the presence of sodium sulphate. Slight variations in the curve for gel formation are also produced when sodium chloride is substituted for potassium chloride. (5) Ferric chloride solutions do not produce gel readily at the ordinary temperature, but give a gel at 60°C. Excess of ferric chloride does not produce a gel even at high temperatures but dissolves a part of the precipitate originally formed. These observations have been explained on the basis of the formation of ferric silicate in the first instance. G.R.S.

Influence of proximity of a solid wall on consistency of viscous and plastic materials. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. *Jour. Phys. Chem.*, **34** [2], 248–62 (1930).—In deriving an expression for the rate of flow of a viscous or plastic material through a straight narrow tube of uniform cross-section under a pressure gradient, it is usually assumed that (1) each particle of the material moves with constant velocity in a straight line parallel to the axis; (2) there is no slip at the wall of the tube; and (3) the velocity gradient at any point depends only on the shearing stress at that point. The authors show that the volume extruded in unit time will depend, for a given stress at the wall of the tube, upon the cube of the radius. While this is true for fluids and nearly true for thick pastes of soil and other minerals, it is found not to be true of such pastes when examined over an extended range of concentration. Turbulence does not account for the discrepancies. The mean velocity, instead of being proportional to the radius, is divisible into two parts, one proportional to it and the other independent of it. The proximity of the solid wall apparently influences the consistency of the material so that a modification of the plastic properties occurs, which imparts an additional velocity to the bulk of the material. By first subtracting this velocity a viscosity constant is obtained independent of the dimensions of the tube. G.R.S.

Determination of the charge on a colloid and mechanism of its coagulation. M. N. CHAKRAVARTI, S. GHOSH, AND N. R. DHAR. *Jour. Phys. Chem.*, **34** [2], 326–35 (1930).—The views of various investigators on the nature of the electric charge on a colloid are briefly discussed. The authors are of the opinion that in all cases the charge originates mostly from the preferential adsorption of ions present in the medium. Silicic acid owes its charge to the preferential adsorption of the silicate ion either from the sodium salt or from the silicic acid which may be present in the solution. The counterparts of the adsorbed ions form a double layer on the sides of the colloid particle whose thickness is considerable, being of the order of 10^{-7} cm. The amount of electric charge on a colloid particle cannot be more than 10^{-6} e.s.u. All ions from a coagulating electrolyte are not effective in coagulation. Only those ions which are very near the colloid particle and possess an energy greater than a definite value can neutralize the charge

on the colloid particles. This explains the necessity of a particular concentration, *viz.*, the threshold value which an electrolyte must reach in order to effect coagulation. If coagulation is effected by electrolytes at a very high temperature, the precipitation values tend to be equal if expressed in equivalents. An ion possessing greater ionic velocity or more absorbable by a colloid should possess a greater coagulating power than an ion which moves slowly and is less absorbed by the colloid. Valency is the main factor in determining the coagulating power of an ion. Coagulation occurs when the electrical density reaches a certain minimum value, beyond which agglomeration is very rapid. The value of this minimum electrical density depends upon the interfacial tension of the colloid particles. The belief that hydrophile colloids are stable toward electrolytes because of their high solvation is not true. The stability of some hydrophile sols depends upon their lower interfacial tension. G.R.S.

Emulsifying powers of bentonite and allied clays, and of clays derived from these by base exchange and hydrolysis. R. M. WOODMAN AND E. MCKENZIE TAYLOR. *Jour. Phys. Chem.*, **34** [2], 299–326 (1930).—The authors have demonstrated that bentonite consists mainly of sodium clay. By hydrolysis it yields free sodium hydroxide. The sodium can be replaced by other metals by a process known as base exchange, or by hydrogen as a result of hydrolysis. The chief concern is with attempts to cause specified clay-containing substances to promote the dual types of emulsions with water and fixed oils. A 1% aqueous suspension of clay emulsifiers was made up. The suspensions and oils were pipetted into 50 cc. cylinders and the type of emulsion formed was judged by appearance, drop tests, and observations on the character and quality of cream. The oils were oleic, linseed, linseed plus oleic, olive, liquefied phenol, cresol, hexalin, methyl hexalin, and petroleum ether. The mixtures were either shaken vigorously immediately, or gently rotated and then vigorously shaken. Results showed (1) clay-containing substances of diverse kinds and from diverse sources, and derivatives prepared from these by base exchange and hydrolysis have been demonstrated to give dual types of emulsions. (2) Clays give dual types of emulsions with fatty acids, fixed oils containing free fatty acids and with phenols and hydrogenated phenols. The hypothesis advanced is that this is due to chemical interaction of the fatty acids with sodium and calcium hydroxides obtained by hydrolysis of the clay when in aqueous suspension, or with breakdown products of the clay itself. The original emulsifier thus undergoes change and soaps are introduced into the system. (3) The changes taking place in the original emulsifier and the different emulsifiers present can easily be made to afford sufficient explanation of the fact that dual types are formed; the clays, as such, are not responsible, and the results are brought into line with the usual emulsion theory. (4) Clays of all kinds are unsuitable as emulsifiers in the preparation of spraying emulsions containing free fatty acids, fixed oils, and phenols because of the liability of the formation of the undesirable water-in-oil type. The results of this extended study of clays modify to some extent the conclusions to be drawn from the previous study of bentonite. G.R.S.

Modern concepts in physics and their relation to chemistry. IRVING LANGMUIR. *Jour. Amer. Chem. Soc.*, **51** [10], 2847–68 (1929). R.G.M.

Iodometric determination of iron. E. H. SWIFT. *Jour. Amer. Chem. Soc.*, **51** [9], 2682–89 (1929).—S. has studied the conditions determining the reliability of the simple iodometric determination of ferric iron suggested by Mohr. Experiments are described which show that an accuracy of 0.2% is obtained when the reaction between the ferric chloride and iodide is allowed to take place in a closed flask for five minutes in about 30 mm. of a solution which contains 3 g. of potassium iodide and from 0.25 to 25 milli-equivalents of hydrochloric acid, and this solution is then diluted to approximately 100 mm. and titrated with thiosulphate. Permanent end-points are obtained

under these conditions. The accuracy of this procedure has also been confirmed by test analyses. Experiments carried out under carbon dioxide show that this accuracy is in most cases partly the result of compensating errors: an incomplete reaction and an "oxygen error." When sulphuric acid is used more acid is required, a higher concentration of iodide is necessary, and the end-points are not as permanent. R.G.M.

Preparation of antimony-free arsenious oxide and estimation of minute amounts of antimony in arsenious oxide. C. W. FOULK AND P. G. HORTON. *Jour. Amer. Chem. Soc.*, **51** [8], 2416–19 (1929).—A rapid and simple method for the preparation of antimony-free arsenious oxide and an application of this method to the qualitative detection and rough quantitative estimation of minute amounts of antimony in arsenious oxide are described. R.G.M.

New differential pressure gage. A. R. OLSEN AND L. L. HIRST. *Jour. Amer. Chem. Soc.*, **51** [8], 2378–79 (1929).—A new, simple, and accurate differential pressure gage has been devised which will permit the study of very slow reactions at any pressure even when an all-glass gage is needed. R.G.M.

Line coördinate charts for representing chemical engineering data. E. A. RAVENSCROFT. *Ind. Eng. Chem.*, **21** [12], 1203–10 (1929).—R. shows how line coördinates may be profitably employed by the chemical engineer. The principle of line coördinates is explained and the relative merits of charts constructed in line coördinates and in Cartesian coördinates are discussed. Five examples of line coördinate charts are given together with their method of construction and their use. R.G.M.

Reduction of tricalcium phosphate by carbon. Effect of silica and alumina on the reaction. K. JACOB, D. REYNOLDS, AND W. HILL. *Ind. Eng. Chem.*, **21** [11], 112 -32 (1929). R.G.M.

Flow of psuedoplastic materials. R. V. WILLIAMSON. *Ind. Eng. Chem.*, **21** [11], 1108–11 (1929).—Many dispersions do not exhibit a real yield-value and cannot be molded, yet their flowing properties are similar in certain respects to the flowing properties of ideal plastics. A graphical method for separating the viscous and plastic resistances of pseudoplastic dispersions into separate measurable quantities serves as a basis for the development of a new equation for pseudoplastic flow. The equation contains three constants. One of these characterizes the viscous properties of the pseudoplastic dispersions and is called the viscosity constant. The ratio of the other two constants is a constant which characterizes the plastic properties of dispersions and is referred to as the plasticity constant. The ratio of the plasticity constant to the viscosity constant gives a constant which appears to be a quantitative measure of that property commonly known as false body. The viscosity and plasticity constants are expressed in the same units and therefore they may be compared in any manner desired. These two constants seem to meet the practical demand for a method of quantitatively evaluating as individual properties the viscous and plastic properties of dispersions. R.G.M.

Titanium white. FOORD VON BICHOWSKY. *Ind. Eng. Chem.*, **21** [11], 1061–63 (1929).—A simple process is described for converting titanium nitride into titanium white by the employment of nitric acid and catalysts. The white so made has a uniquely low specific gravity. R.G.M.

Drying solids. II. T. K. SHERWOOD. *Ind. Eng. Chem.*, **21** [10], 976–80 (1929).—The effects of adjoining dry surfaces, radiation from the surroundings, and air velocity on the rate of drying of solids in the constant rate-of-drying period are described. The falling rate period is shown to be in general divisible into two zones: in the first the rate of drying decreases because of a decrease in the wetted surface; in the second and final zone of the drying process internal liquid diffusion controls the drying. A simple empirical equation is found to fit the data reasonably well in the falling rate

period, and to afford a simple basis of calculation in drier design. For Part I see *Ceram. Abs.*, **9** [2], 134 (1930). R.G.M.

Method of construction of humidity charts, with auxiliary tables. M. LOURIE. *Chaleur ind.*, **10,** 572–83 (1929).—In addition to the necessary calculations the following tables are given: (1) specific weights of water-vapor contained in humid air; (2) partial pressure of water-vapor contained in humid air; (3) volume of humid air containing 1 kg. of dry air; (4) the quantity of heat in the water-vapor contained in humid air; and (5) quantity of heat and the humidity of humid air at 745 mm. A.J.M.

Contribution to the microchemical analysis of glass. W. GEILMAN AND K. BRÜNGER. *Glastech. Ber.*, **7** [8], 328–32 (1929).—Among the microscopic methods of determining copper in glass the outstanding methods are those of determining it as the triple salt, potassium-copper-lead nitrite ($K_2PbCu(NO_2)_6$), which has a characteristic crystal form of dark brown to black cubes 10–60μ in size which are readily recognizable at 100 to 150 power magnification, or by the color reaction resulting from the formation of $[(C_6H_5CHO)(C_6H_5CNO)]Cu$. Directions for conducting these tests are given in detail, with variations in procedure, to be followed in the cases of various types of glass such as lead, barium-, antimony-, and tin-containing, zinc, cobalt, nickel, and opaque glasses which are opacified with TiO_2, cryolite, or phosphate enumerated. Lead is also determined by the triple nitrite except that a slight addition of copper acetate is necessary. Variations in this procedure for various types of glasses are pointed out. E.J.V.

Meaning and measurement of plasticity. E. KARRER. *Ind. Eng. Chem.*, **21** [8], 770–73 (1929).—K. defines plasticity and discusses the large number of factors involved in its determination for a given material. Literature covering various investigations is cited. R.G.M.

Density of crystals on cooling under high pressures. G. TAMMANN AND E. JENCKEL. *Z. anorg. allgem. Chem.*, **186** [1], 141–44 (1930).—The density of glasses increases as the pressure under which they solidify is increased. Experiments were made to determine whether crystals increased in density under similar heating conditions. When various substances were allowed to crystallize under pressures of 5700 kg./cm.^{2} no increase in density was noted. It has been maintained that feldspars decrease their density on heating. On heating them just below their melting point under 2860 kg./cm.^{2} pressure no change in density was noted on cooling. A description of the apparatus used in these studies is given. L.T.B.

Petrographic study of lead and copper furnace slags. ROY D. MCLELLAN. Amer. Inst. Mining and Met. Eng., *Tech. Pub.*, No. 305, Class D; *Mining and Met.*, **11** [279], 18–19 (1930).—This paper has resulted from the study of thin sections, from a large number of commercial lead and copper furnace slags, with the help of the petrographic microscope. It is an analytical survey of these slag problems designed to simplify the course to be followed in future slag studies by synthetic fusions. F.P.H.

Constitution of silicate melts. H. SALMANG. *Glastech. Ber.*, **7** [7], 277–79 (1929).—It is easier to obtain an insight into the constitution of molten silicates through the study of their chemical reactions than their physical properties. In basic melts, corresponding to the composition $RO{\cdot}SiO_2$, the dissociation of the oxides exceeds that in acid melts of silicate compounds. The oxides MgO, Al_2O_3, Fe_2O_3, and Mn_2O_3 incline to enter into melts as acids. E.J.V.

Determination of the alumina content of aluminoborosilicates. O. W. KRASNOWSKY. *Z. anal. Chem.*, **79,** 175–83 (1929).—Experiments with solutions containing Al, B, Ca, Mg, and Na salts show that the presence of as much as 30% of B_2O_3 does not interfere with the precipitation of $Al(OH)_3$, provided the conditions recommended by Blum are maintained. If more than 10% of Al_2O_3 is present, however, it is advisable to make a double precipitation of the $Al(OH)_3$. The conclusion is drawn that it is

unnecessary to remove B_2O_3 in silicate analysis especially since a considerable part of the B is volatilized with steam during the analysis. (*C.A.*)

Silicates in chemical industry, especially with regard to their resistance to chemical agents. VLADIMÍR ŠKOLA. *Chem. Obzor*, **4**, 281–86, 317–27 (327–28 English) (1929).—A new method, based mainly upon determining the solubility of the granular material in various acids or other liquids, has been devised for determining probable results in service. About 30 test pieces are formed, $^1/_3$ of which are used for determining compressive strength and the rest are exposed to chemical reagents. After a certain time (with acids and first-class material about 250 to 350 days), one-half are taken out and tested for compressive strength. The other half are tested after being thoroughly boiled with distilled water. The examination may be completed by determining the capacity for taking up water or by chemical analysis. (*C.A.*)

Rational analysis of clays. L. SCHAETZER. *Corriere ceram.*, **10** [6], 203–207 (1929).—Rational analysis of clays is chiefly concerned with the quantitative determination of kaolinite (a hydrosilicate of alumina, $2SiO_2$, Al_2O_3, $2H_2O$). When heated to 600° it loses its two molecules of water of combination. Treating with inorganic acids dissolves the alumina content while bases dissolve the silicas. The fact that the rational method of analysis gives for the most part slightly erroneous results does not deny its technical value, and S. demonstrates the inaccuracy of the chemical analysis method as well. A method combining both the chemical and rational analyses, which gave very good results, is explained. M.V.K.

Determination of silicon. T. HECZKO. *Z. anal. Chem.*, **77** [9–10], 327–28 (1929); *Sprechsaal*, **62** [51], 948 (1929).—During the analysis the silicic acid which is separated may become impure. To ascertain exactly its quantity, the substance which has been heated to redness must be mixed with hydrofluoric and sulphuric acids, evaporated to dryness, then heated to redness again and the remaining sediment deducted from the value first ascertained. The time required for this can be shortened thus: after the addition of the acids an appropriate quantitative filter is crumpled up and pushed in the crucible in such a way that it comes in contact with the liquid. If it is a question of only a small quantity of SiO_2 which requires but little acid, the paper will absorb the acid completely and that which remains can then be heated to redness. If there is a greater quantity of acid, it must first be evaporated, but here also the parts of the filter projecting out of the liquid really accelerate the whole process. M.V.K.

Quantitative determination of quartz in clay. ANON. *Geognostische Jahresheft*, **40**, 105 (1927); *Sprechsaal*, **62** [51], 949 (1929).—Molten potassium bisulphate does not dissolve quartz, but, on the other hand, it dissolves clay completely. The silicic acid which is thereby precipitated in an amorphous state cannot be quantitatively separated from quartz. But this is accomplished when a certain quantity of ammonium sulphate is added to the potassium bisulphate. Thus the melting temperature is greatly lowered, but the clay goes completely though slowly into solution, and the quartz, in the form of a very fine powder, is not affected. The usefulness of this method is shown in analyses. M.V.K.

Heat capacities in some aqueous solutions. FREDERICK D. ROSSINI. Bur. Stand., *Jour. Research*, **4** [2], 313–27 (1930).—The problem of properly evaluating the heat capacities of the constituents of aqueous solutions is discussed, and the methods of calculating from specific heat data possessing the necessary qualifications, the apparent molal heat capacity of the solute and the partial molal heat capacity of the H_2O are given. The importance of the results in interpreting the behavior of ions and molecules in aqueous solution and their relation to the Debye-Hückel theory of strong electrolytes are discussed. R.A.H.

Ceramic magnesium silicates. Sintering process and the constitution of ceramic

masses. II. O. KRAUSE. *Chem. Zentr.*, **1**, 2570 (1929); for abstract see *Ceram. Abs.*, **8** [9], 666 (1929). (*B.C.A.*)

BOOKS

A Chemical Dictionary. INGO W. D. HACKH. Blakiston, Sons & Co., Inc., Philadelphia, Pa. 800 pp. Price $10.00. This is a "dictionary" as the word is ordinarily understood. A really large number of chemical names and terms are listed. The book states and defines the theories, laws, and conventions of chemistry and chemical terminology. Descriptions of chemical apparatus, equipment, and instruments of various kinds are given. An interesting feature of the work is the attention given to the names of investigators who have built up the science. H. has taken a broad view, and includes many terms from other sciences, making the work quite complete and general. The book represents a thorough and successful effort to supply a useful reference. Reviewed in *Can. Chem. Met.*, **14** [3], 56 (1930). E.J.V.

Handbook of Chemical Microscopy. E. M. CHAMOT AND CHAS. W. MASON. John Wiley & Sons, New York. Vol. I. 450 pp. Price $4.50. Volume I deals with the principles and use of microscopes and accessories. Physical methods in the study of chemical problems are discussed. The technique of microscope operation is considered in great detail. This book can be recommended as a splendid study based on the experience and research of the authors, and a thorough examination of the literature on the subject. Reviewed in *Can. Chem. Met.*, **14** [3], 56 (1930). E.J.V.

Surface Equilibrium of Colloidal Solutions. LECOMTE DU NOUY. Written in French. Published by Masson, Paris. A.J.M.

Introduction to the Study of Theoretical Physics. RÉNÉ FORTRAT. Written in French. Published by Hermant, Paris. A.J.M.

PATENTS

Products containing calcium aluminate. J. A. BONTHRON AND T. R. HAGLUND. Swed. 66,588, Jan. 2, 1929. Lime-containing and alumina-containing raw materials are melted together. To eliminate completely or partially the silica-containing impurities, the alumina-containing raw material is first subjected to a reducing melting without or with a minor addition of the lime-containing raw material, while the major part of the latter is not applied to the charge till the reducing melting has been completed. (*C.A.*)

Materials containing calcium aluminate. J. A. BONTHRON AND T. R. HAGLUND. Swed. 65,215, May 22, 1928. Sulphide or sulphidic ores are desulphurized by heating with raw materials containing Al_2O_3. The Al_2O_3-containing slag is oxidized or decomposed with re-formation of alumina. All or part of the products obtained by the oxidation or decomposition of the slag, with or without an addition of another alumina-containing raw material, for instance bauxite, are heated with a quantity of lime-containing materials sufficient for the formation of Ca aluminates. (*C.A.*)

Manufacture of silica gel and of calcium or sodium silicate. F. RICARD. Fr. 632,509, April 9, 1927. Limestone mixed with powdered coal is burned at 800 to 1000° and the resulting lime is boiled with sodium carbonate to produce a solution of sodium hydroxide and a precipitate of calcium carbonate for use again. The solution is boiled with finely-divided siliceous material, filtered, and treated with carbon dioxide from the lime kiln. The silica gel is removed and the filtrate boiled with more lime to regenerate sodium hydroxide. Alternatively, the sodium silicate solution may be treated with milk of lime to obtain calcium silicate or evaporated to recover water glass. (*B.C.A.*)

General

Lignin extract as bonding agent for ceramic bodies. R. M. KING. *Ceram. Ind.*, **14** [1], 62–64 (1930).—In a previous article (see *Ceram. Abs.*, **7**[10], 692 (1928)) numerous data were given showing the effect of lignin extract as a dry body strengthener. This marked property prompted the question: How does this material function when added to the clay body? The answer resolved itself into two specific questions: (1) Does the extract function as a direct bond through its "stickiness" or adhesiveness, or, (2) does it have an indirect bonding action through its ability to disperse or coagulate the clay? While lignin extract acts to a limited extent as a direct agent, the greater part of the increased strength of a body when it is used is due to the dispersing effect it has upon the clay particles. Tannic acid, which has been used for increasing the plasticity of clays, gives the same effect upon clays, but is not as effective in increasing the dry strength of a clay as is lignin extract. Lignin extract may be more effectively used than tannic acid to increase the dry strength of clays and it is presented to the ceramic industry as an organic material which may be used as an electrolyte, a dry body strengthener, and one which will burn out on firing without the attendant possibility of lowering the vitrification range of the ware. F.P.H.

Properties of steam. ROGER MARTIN. *Chaleur ind.*, **10**, 605–14 (1929).—M. reviews the work on the subject which has been done in various countries. Tables and graphs give values of the specific heat and the heat required to raise the temperature from the temperature of saturation to 550°C at pressures from 1 to 120 kg. A.J.M.

Friction of steam in pipes and tubes. JEAN REY. *Chaleur ind.*, **10**, 519–25 (1929). A.J.M.

Most economical steam pressure. PAUL GILLI. *Chaleur ind.*, **11**, 3–14 (1930). A.J.M.

Heat of vaporization of water and specific volume of saturated steam for temperatures up to 210°C. MAX JAKOB. *Z. Ver. deut. Ing.*, April, 1929; *Chaleur ind.*, **10**, 464 (1929). A.J.M.

Utility of thermal control. H. GUILLON. *Chaleur ind.*, **11**, 45–50 (1930). A.J.M.

Exchange of heat in regenerators. HELMUTH HANSEN. *Z. Ver. deut. Ing.*, March, 1929. A.J.M.

Characteristic curves of heat exchangers. MARCEL VERON. *Chaleur ind.*, **10**, 469–78 (1929). A.J.M.

Considerations on radiation and convection in design of boilers. M. RECHNIEWSKI. *Bull. Tech. Bureau Veritas*, Nov., 1928. A.J.M.

Protection for boilers and fireboxes. E. PIERNET. *Chaleur ind.*, **10**, 558–59 (1929).—A soluble salt reacts in the pores of the refractory with lime and forms an abundant precipitate which closes the pores. A.J.M.

Heat transfer from a gas stream to a bed of broken solids. C. C. FURNAS. *Ind. Eng. Chem.*, **22** [1], 26–31 (1930). R.G.M.

Concrete free from air and pores. EMPERGER. *Beton und Eisen*, 21 (1929); *Tonind.-Ztg.*, **53** [98], 1730 (1929).—E. communicates a new method which may revolutionize concrete and reënforced concrete building. Because every concrete material contains air, pores are found in the proportion of 5 to 10%. If the mortar material is mixed dry and then the water added, the air is expelled during the further mixing and does not reënter the mortar. A resistance to pressure up to the double value of the normal is obtained. Simultaneously, the imperviousness to water and the wearing qualities are heightened. At the suggestion of E., several machine factories are busy

with the manufacture of appropriate mixing apparatus, and no doubt concrete without pores will soon be used extensively in construction. M.V.K.

Clay as filler for common materials. ANON. *Pit and Quarry*, **19** [9], 60 (1930).—The extremely finely divided nature of clays and their low cost make them of value as adulterants and as mineral fillers for rubber, linoleum, oil-cloth, etc. Kaolin and certain other white clays are extensively employed in the manufacture of high-grade paper. Ocher and iron-stained clays are used mainly in linoleum, paint, and wall coatings. Clay competes with whiting in the manufacture of mechanical rubber goods. It appears to be adapted for use in road asphalt mixtures, plastic roofing, flooring, and for any purpose requiring an inert, extremely fine-grained material. E.P.R.

Drying clays and clay bodies. V. BODIN AND P. GAILLARD. *Bull. Soc. d'Encour.*, **128,** 453–80 (1929).—The physical and chemical properties of six French clays and brick mixtures were determined. Drying experiments were carried out on these clays and mixtures with apparatus by means of which a current of air of definite velocity and humidity was passed over the specimen while variations in weight were automatically recorded. The effect of additions of nonplastic materials, in different percentages and grain-sizes, on the drying behavior of a plastic clay was also studied. The drying periods of the clays and mixtures varied from 155.6 to 8.8 hrs. for specimens 6 cm. thick; these times were greatly reduced with specimens 3 cm. thick. The addition of a small quantity of grog (10%) decreased the drying period; further additions up to 40% reduced it further, but in decreasing proportions. No direct relation was discovered between size of grog and drying time. (*B.C.A.*)

Meaning of "heavy" clay products. W. D. RICHARDSON. *Clay-Worker*, **93** [3], 220 (1930).—The responsibility for the adoption of the term "heavy" in connection with clay products is sought, as it is pointed out that while the Heavy Clay Products Division is composed mostly of those who manufacture building brick, with a few engaged in the manufacture of hollow building tile, drain tile, sewer pipe, and roofing tile, the only one that could be called "heavy" is sewer pipe. By comparing the products of the various Division members it is evident that the name has no special significance as to the products made by the members and is a misnomer. A new name for the Division is suggested. E.J.V.

District manager's viewpoint. CHARLES A. BOWEN. *Clay-Worker*, **93** [3], 196–98 (1930).—B. points out the importance of both individual and group effort in bringing about an increase in business of brick manufacturers. Order takers are not salesmen and cannot compete with real salesmen. The work of the district manager and his staff under the centralized plan of conducting the C.B.M.A. is discussed. The cost of real salesmanship is pointed out as actually being lower than it seems as there are results being obtained for the increased pay where there may be none for the lower pay given ordinary men. A manufacturer must be alive to all conditions, and must not be too modest in his advertising and pushing his own business. E.J.V.

Coördination of the sizes of building units. P. H. H. DUNN. *Clay-Worker*, **93** [3], 213 (1930).—The work on the standardization of masonry openings from its inception is discussed. It was thought that the brick was the key unit in a wall and so a unit of measure or module which is equal to the length of a brick plus a joint was considered as a logical unit of measure. A brick which would seem to fit requirement was proposed, having the size of $8^1/_2$ by 4 by $2^1/_2$ inches. The entire proposition of a possible increase in brick size and coördination of standards for masonry materials is to be presented to the various brick associations. E.J.V.

Ohio drain tile first made in 1850. ANON. *Brick Clay Rec.*, **76** [5], 338 (1930).—Drain tile, horseshoe shaped, was first made in Ohio near Lorain, in 1850. The next record of the manufacture of drain tile was found at Milford Center near Columbus, in

1857. There were 13 plants for the manufacture of drain tile in operation in the Maumee Valley in 1870, and this section still has the largest number of drain tile manufacturers. Ohio's production of drain tile in 1925 was about one-third of that of the entire U.S. There are now 36 large plants in operation in the state. E.J.V.

Marking of imported brick and tile. ANON. *Pottery Gaz.*, **55** [633], 454 (1930).—The Standing Committee appointed by the Board of Trade recommend that imported tile of earth or clay other than those covered by the Pottery Order and exclusive of enameled tile and mosaics should bear an indication of origin impressed, embossed, stamped, or printed on each tile. They recommend that refractory brick, block, and tile, other than metallic brick or block, should be required to be impressed or embossed with a mark of origin, not only on sale or exposure for sale, but also on importation. E.J.V.

DuPont develops new explosives. ANON. *Pit and Quarry*, **19** [11], 93 (1930).—E. I. duPont de Nemours & Co. announces that the eastern laboratory has recently developed two new low density gelatine explosives which will be marketed under the names of Gelex No. 1 and Gelex No. 2. These new products are intended for use in ore mines and for the underground mining of limestone and other nonmetallic minerals. Both Gelex No. 1 and Gelex No. 2 are extremely cohesive and plastic so that they will load well in upward pointing holes. E.P.R.

List of manufacturers of permissible equipment and explosion-proof accessories. L. C. ILSLEY. Bur. Mines, *Information Circ.*, No. 6222, 5 pp. (1930).—Increased interest is being manifested in the subject of approved equipment for use in gassy and dusty mines. The U. S. Bur. of Mines receives numerous inquiries as to where accessories available for permissible applications can be obtained. The number of manufacturers holding approvals for complete outfits is constantly increasing. This circular has been prepared to present information on the subject in a way that should make it easily available. Detailed information may be obtained from the current list of Bur. of Mines approved mine equipment which is issued every 6 months. The present report gives a list of manufacturers of permissible mining equipment. R.A.H.

Review of accident-prevention work in nonmetallic mineral industry. W. DEAN KEEFER. *Pit and Quarry*, **19** [11], 49 (1930).—In general, there has been a growing interest in the nonmetallic mineral industry in accident prevention work, and it is probable that statistics for the year will show an increasing number of companies and men engaged in continuous safety work. E.P.R.

Mine ventilation chart. SYDNEY C. MIFFLEN. *Eng. Mining Jour.*, **129** [1], 30 (1930).—A chart comparing shaft area, perimeter of shaft, mine resistance, h.p. of air, air pressure, and cu. ft./min. for the flow of air through mines is given. E.C.C.

Cement industry investigates metallurgical grinding methods. A. ANABLE. *Eng. Mining Jour.*, **129** [4], 188–91 (1930). E.C.C.

Make ceramics known to the public. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **9** [3], 54–55 (1930). E.J.V.

Plant proving and job fitting. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **9** [3], 55–56 (1930). E.J.V.

The engineer's viewpoint. R. S. TILDEN. *Clay-Worker*, **93** [3], 194–95 (1930).—T. presents the engineer's viewpoint in regard to merchandising. His idea is that the job of the engineer is promotional. While the matter of costs is of prime importance to contractors, there is also the need to present dry facts in such a way that the prospective purchaser or user is interested. In other words there is a need for converting the minds of men to an appreciation of the sterling qualities of brick. E.J.V.

Economic factors in chemical plant locations. C. W. CUNO. *Ind. Eng. Chem.*, **21** [8], 738–40 (1929).—C. outlines the various types of industries and the factors to be considered in determining a suitable location. These factors are (1) raw materials,

(2) labor, (3) fuel, (4) power, (5) water, (6) transportation facilities, (7) freight rates, (8) markets, (9) climate, (10) taxes and corporation feeds, (11) municipal restrictions, and (12) competitive, feeder, and consumer industries. The order of importance of these factors will vary with the particular plant under consideration. R.G.M.

Two examples of the smaller industrial research organizations. WASHINGTON PLATT. *Ind. Eng. Chem.*, **21** [7], 659–61 (1929).—P. describes two types of small research organizations. One type is that used by a comparatively small industrial concern, and the other used by a trade association. R.G.M.

Structure of an industrial research organization. C. M. STINE. *Ind. Eng. Chem.*, **21** [7], 657–59 (1929).—S. presents an outline of a research organization for industrial work. R.G.M.

Michigan to lease its mineral lands. ANON. *Pit and Quarry*, **19** [10], 90 (1930).—A definite policy under which it will dispose of nonmetals taken from land in which the state owns mineral rights, by lease, will be declared soon by the conservation commission. E.P.R.

Departmental application of overhead. J. J. BERLINER. *Pit and Quarry*, **19** [8], 40–44 (1930).—The items of overhead or indirect charges consist of three principal subdivisions: (1) indirect material; (2) indirect labor; (3) indirect expense. These overhead items do not affect all departments alike. Some of them apply to all and others only to particular departments. This article covers their application in all cases. E.P.R.

Short course on heavy clay products. H. R. MCMAHON. *Clay-Worker*, **93** [3], 208 (1930).—One of the features of the short course held at Iowa State College, Ames, Iowa, January, 1930, was the demonstration of new applications of welding to the maintenance and repair of the clay products plant. Auger design and die balancing were treated in a talk given by a representative from the Fate-Root-Heath Co., Plymouth, Ohio. "Blower and Fans," by A. K. Friedrich, professor of mining engineering, was another feature of the program. Henry Giese discussed hollow tile buildings. E.J.V.

1931 ceramic exposition. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **9** [3], 53–54 (1930). E.J.V.

Research and industrial progress in ceramics. ANON. *Can. Chem. Met.*, **14** [3], 20–21 (1930).—Some of the outstanding papers read at the AMERICAN CERAMIC SOCIETY Meeting at Toronto are given in abstract form and are discussed. E.J.V.

American Ceramic Society at Toronto. ANON. *Brick Clay Rec.*, **76** [4], 236–42 (1930).—A report of the meeting held in Toronto is given, the main general topics brought up being the creation of a "Fellow" classification of members, a consideration of masonry standardization, a ceramic products exposition for next year's convention at Cleveland, a suggested increase in dues to increase the scope of activities, and a start toward the formation of a management division for executives. Abstracts of papers presented in the Heavy Clay Products Division are given. E.J.V.

Refractories manufacturers adopt code of business ethics. ANON. *Pit and Quarry*, **19** [12], 99 (1930).—The American Refractories Institute has published a pamphlet containing a code of ethics. E.P.R.

Proceedings of the Glass Division. ANON. *Glass Ind.*, **11** [3], 51–57 (1930).—A report of the Meeting of the AMERICAN CERAMIC SOCIETY held at Toronto is given with abstracts of 21 papers presented and discussed included. E.J.V.

National Brick Manufacturers Association. ANON. *Clay-Worker*, **93** [3], 199–202 (1930); for abstract see *Ceram. Abs.*, **9** [4], 317 (1930). Research program of N.B.M.A., *Clay-Worker* **93** [3], 203 (1930). E.J.V.

C. B. M. A. meeting. ANON. *Brick Clay Rec.*, **76** [3], 170–73 (1930); *Clay-*

Worker, **93** [3], 184–85(1930).—A full report of the meeting held at Memphis, Tenn., Feb. 3 to 7, is given, with brief abstracts of some of the outstanding papers read. Wm. Schlake was elected president for the tenth time. E.J.V.

Accomplishments of Tile Association. ANON. *Brick Clay Rec.*, **76** [4], 244–46 (1930); *Clay-Worker*, **93** [3], 210–12 (1930).—At the meeting of the Structural Clay Tile Association in Columbus, Ohio, Feb. 12 to 14, the following outstanding accomplishments were reported: (1) building up of a personnel of engineers in various centers; (2) development of a new light-weight unit; (3) a national advertising campaign; (4) start of a survey on the design of hollow building units with a view of cutting laying costs; (5) initiation of a trade practice conference to be held in St. Louis; and (6) in favor of a general combination of all clay products for the purpose of trade promotion and research. E.J.V.

Southwest Clay Products Institute. ANON. *Brick Clay Rec.*, **76** [5], 322–23 (1930).—At the first annual convention held at Dallas, Texas, February 25 and 26, approximately 50 delegates from firms representing more than 90% of the clay products industry in Texas, met and reviewed what had been accomplished during the past year and made plans for even greater achievements during the current year. Some details of the meetings are given. Illustrated. E.J.V.

Wisconsin Clay Products Manufacturers. ANON. *Brick Clay Rec.*, **76** [5], 323 (1930).—A report of the second annual meeting held at Madison, February 26 and 27, at which the following papers were presented: "The Use of Tunnel Kilns for Firing Heavy Clay Products," by Philip Dressler; "The Comparison of Cost between Brick and Frame Houses," by J. J. Stein; "The Firing of Face Brick in Round Downdraft Kilns," by A. R. Gmeiner; "Solving Our Drier Troubles," by Jacob Hockers; "Things We Can Do to Increase Drain Tile Sales," by Roy Palmer; "Solving Some Problems in the Flow of the Clay through Dies," by Edward E. Krauss. E.J.V.

Organization of industrial research. WASHINGTON PLATT. *Ind. Eng. Chem.*, **21** [7], 655–57 (1929).—Facts are presented which were brought out at the Symposium held at Syracuse, N. Y., by the American Chemical Society. R.G.M.

Clay industry to organize a trade association. ANON. *Pit and Quarry*, **19** [12], 66 (1930).—Clay-mining companies, including importers and jobbers, are about to organize a trade association. E.P.R

New markets for blast-furnace slag. C. L. MCKENZIE. *Pit and Quarry*, **19** [7], 43–44; [8], 59–60 (1930).—The publication by the National Slag Assn. of symposiums, which now number 19, each one assembling all the known facts as to quality, characteristic, or use has been continued during 1929. Abstracts of each symposium have been published in *Pit and Quarry* from time to time, the first seven having been covered during 1928. A list of the symposiums abstracted and the issues in which they were published during 1929 is given. E.P.R.

Report of Bureau of Engineering to Research Committee. A. T. GOLDBECK. *Pit and Quarry*, **19** [9], 50–52 (1930).—At the last annual meeting of the National Crushed Stone Assn. the research work of the new laboratory was briefly summarized. E.P.R.

National Materials Handling Meeting. ANON. *Pit and Quarry*, **19** [9], 55 (1930).—The Third National Materials Handling Meeting of the A.S.M.E. was held in Chicago, March 5–7. The meetings covered widely diversified subjects in materials handling and the shipment of merchandise equipment. E.P.R.

Pittsburgh exhibits golden jubilee. ANON. *Crockery Glass Jour.*, **108** [1], 61 (1930).—The many and varied displays in china, glassware, and allied lines will make the exhibit memorable. Exhibitors promise an array of new shapes and designs. E.P.R.

National Safety Council plan for systematized safety meetings. W. DEAN KEEFER. *Pit and Quarry*, **19** [8], 69–70 (1930).—In all kinds of industrial activities an increasing interest is being manifested in the prevention of accidents. Many organizations conduct systematic practices and hold regular or periodic meetings. Others are desirous of inaugurating such practices. E.P.R.

The Ceramic Society. ANON. *Pottery Gaz.*, **55** [633], 441–47 (1930).—The February Meeting was entirely devoted to a discussion of problems which has been submitted by members in the form of written questions. The questions dealt with were as follows: (1) What is the objection to using slip direct from the mixing ark for casting instead of first converting it into plastic clay and then blunging it up again into slip? (2) Why is it advisable to maintain a "soaking" heat during the later stages of biscuit (3) What is the cause of bone china going black in oven and enamel kiln? (4) What is the cause of the firecracking of cup handles? The handle is quite firm onto the article, but a fine hair crack shows round the edge. There is proper fettling after sticking up, and there are no signs of cracks before the cups go into the oven. (5) What is the cause of rutile-stained body coming out of the oven a different color when fired in green saggers, likewise ware used for "filling," *i.e.*, inside vegetable dishes, etc., being a darker color; or, in the case of boxed cups, the inside being of a darker color than the outside? The discussion of each of these questions is given. E.J.V.

Come to the potteries. II. ANON. *Pottery Gaz.*, **55** [632], 279–83 (1930).—Descriptions of some of the potteries to be seen in Stoke and Hanley, two of the towns in the Potteries towns which are included in the Federated Borough known as Stoke-on-Trent, are given. Illustrated. *Ibid.*, [633], 450–53 (1930).—In this article the potteries in the towns of Burslem and Tunstall are discussed and described. Illustrated. See also *Ceram. Abs.*, **9** [3], 239 (1930). E.J.V.

Wedgwood Bicentenary Celebration. III. ANON. *Pottery Gaz.*, **55** [632], 275–78; **IV.** *Ibid.*, [633], 449 (1930); see *Ceram. Abs.*, **9** [3], 239 (1930). E.J.V.

First section of clay plant merger completed. A. B. ANDREWS. *Brick Clay Rec.*, **76** [5], 304 (1930).—With the consolidation of 24 companies manufacturing sewer pipe, conduit, and other vitrified clay products, representing a combined capitalization of $30,000,000, the first section of a gigantic merger has been completed. The second section will involve companies manufacturing hollow building tile, fireproofing, and semiglazed tile, and the third section will consist of four units of already consolidated nationally known brick companies manufacturing furnace brick, fire clay, and a complete diversified line of brick. These three sections will result in a holding company representing $75,000,000 and which will be known as the Ceramic & Steel Products Co., incorporated under the laws of Delaware. This consolidation was brought about for the purpose of standardizing manufacture so that the consumer might purchase quality manufactured articles at minimum costs. E.J.V.

Install new kilns. ANON. *Clay-Worker*, **93** [3], 216 (1930).—A contract for the construction of two tunnel kilns for the proposed new $750,000 plant which the Hall China Co. at East Liverpool, is to build has been awarded to the American Dressler Tunnel Kiln, Inc. One of the kilns will be of the open-fire multi-burner type, 355 ft. in length. The other will be a muffle type, 201 ft. long. Both kilns will be used for one-fire products. E.J.V.

Oklahoma's newest brick plant. ANON. *Brick Clay Rec.*, **76** [5], 318–19 (1930).—A description of the equipment and layout of the Western Brick Co. plant located at Clinton, Okla., is given. Face brick, common brick, and hollow tile will be manufactured. An initial production of about 60 M brick per day will be started, though the equipment can be increased to a production of 100 M a day if necessary. E.J.V.

Concentrated brick display. W. W. SNYPP. *Brick Clay Rec.*, **76** [4], 260–62

(1930).—The brick display room of the Cleveland Builders' Supply Co. has a wall space 7 ft. high and 15½ ft. wide which contains 138 drawers of brick display panels, each of which is 15 in. high by 27 in. long. The panels display 72 different textures and color combinations in bond panels and California stucco panels, as well as enamel and rustic brick panels. E.J.V.

Refractories firms merge. ANON. *Pit and Quarry*, **19** [9], 77 (1930).—General Refractories Co., Philadelphia, Pa., announces that it has acquired all of refractories properties of Evens & Howard Fire Brick Co. of St. Louis, Mo. E.P.R.

Onondaga produces new hospital tray service. ANON. *Crockery Glass Jour.*, **108** [1], 70 (1930).—A close study of the requirements of hospitals for a tray service has resulted in the Onondaga Pottery Co., placing on the market a special assortment of shapes that has proved to be of great value to such institutions. E.P.R.

1928 clay activities. JEFFERSON MIDDLETON. *Brick Clay Rec.*, **76** [4], 247 (1930).—The total quantity of clay sold by domestic producers in 1928 amounted to 4,026,332 short T. as compared with 3,849,176 in 1927. The total value of clay sold in 1928 was the highest ever recorded and amounted to $14,200,739, nearly 1% more than the figures in 1926, which year held the previous record. Fire clay, which constituted 69% of the total quantity of clay sold in 1928, increased 3% in quantity and decreased 3% in value compared with 1927. Stoneware clay decreased 3% in quantity but increased 2% in value. Slip clay sales decreased 7% in quantity and nearly 5% in value. Ball clay increased only 1% in quantity and nearly 8% in value. Kaolin increased 9% in quantity. E.J.V.

Lime and cement works in New Zealand. ANON. *Official Handbook of N. Z.*, p. 581 (1930).—The figures for the latest available year (1927–28) are number of works 27, persons engaged 915, wages £218,017, value of land and buildings £338,107, value of machinery and plants £511,908, H.P. 17,283, value of materials used £228,654, value of output £961,561. H.H.S.

Brick, tile, and pottery works in New Zealand. ANON. *Official Handbook of N. Z.*, p. 581 (1930).—The figures for the latest available year (1927–28) are number of works 71, persons engaged 1300, wages £295,848, H.P. 5217, value of land and buildings £363,401, value of machinery and plant £239,935, brick manufactured 63,382,389, common, 1,206,225 fire, total value of brick £277,892, value of pottery £402,328, value of all £680,220. H.H.S.

Belgium brick exports drop sharply. ANON. *Brick Clay Rec.*, **76** [5], 305 (1930).—Total brick exports from Belgium to the U.S. during 1929 amounted to 5,878,000 brick, compared to 63,419,500 brick in 1928, and 79,286,300 brick in 1927. No exports to the U.S. were made during the last seven months of the year, owing to the lowering of prices in the U.S. A detailed statement of exports of brick for the first 11 months of the year is given. E.J.V.

New German bottle syndicate plans activities. A. DOUGLAS COOK. *Commerce Repts.*, **10**, 665 (1930); *Pottery Gaz.*, **55** [633], 469 (1930).—A new bottle syndicate has been established in Düsseldorf under the name of "Deutsche Flaschen Verkaufs G.m.b.H." (German Bottle Sales Co.) Both domestic and foreign sales will be handled by the syndicate, and all the leading bottle manufacturers, most of whom were members of the Association of German Bottle Manufacturers, have become members, controlling about 98% of the total output. Exports, which prior to the World War amounted to about 35% of the output, have declined to approximately 20%. E.J.V.

Prussian State Porcelain Factory. ANON. *Pottery Gaz.*, **55** [633], 469 (1930); reprinted from *Frankfurter Z.*—Progress is being made in the reorganization of this factory. The Director of the Frankfurt Fair Bureau, Josef Modlinger, is to be the

commercial director, and the artistic management will be in the care of Herr Pechmann. E.J.V.

Polish glass industry in 1929. BRUNON BALINSKY. *Gazeta Handlowa; Pottery Gaz.*, **55** [633], 469 (1930).—The general economic crisis had its effect on the Polish glass industry, which was hampered by inability to buy at home and by foreign artificial barriers. The total quantity of window glass sold inland in 1929 amounted to 3,294,000 sq. m. The total producing capacity is 6,500,000 sq. m. The exports of window glass amounted to 80,000 sq. m. E.J.V.

Book Reviews

Sprechsaal Calendar, 1928. J. KOERNER. Müller & Schmidt, Coburg. A pocket booklet containing a diary for the year, 216 pages of condensed technical data arranged alphabetically, and 97 pages of advertising matter with index. Complete chemical, and in some cases, also rational analyses and melting points of some 275 clays are listed together with sources of supply. Several pages are devoted to similar information of other raw materials, such as feldspar, quartz, dolomite, fluorspar, limestone, magnesite, and talc. F.A.W.

Sprechsaal Calendar, 1929. J. KOERNER. Müller & Schmidt, Coburg. Contents follow closely the 1928 edition with the addition of some new data. Description is given of a new type of triaxial diagram developed by Josef Wolf in which the molecular ratios are plotted (see *Sprechsaal*, pp. 43–45 (1927)). F.A.W.

Keramische Rundschau Calendar, 1930. Keramische Rundschau, Berlin. A diary containing information of a non-technical nature. F.A.W.

Handbook for Ceramists, 1930. Keramische Rundschau, Berlin. A list is given of some of the more common faults encountered in the manufacture of clay, enamel, and glassware with the corrective measures to be used. Further chapters are devoted to patent law, tables, technical literature, list of ceramic educational institutions and associations in Europe, and closes with an alphabetical list of sources of supply for raw materials and equipment. F.A.W.

Tonindustrie Calendar, 1930. Chem. Lab. für Tonindustrie, Berlin. Two volumes. Vol. 1 contains a diary for 1930 and general information covering Seger cones, mathematical formulas, foreign coinage, first aid, etc. Vol. 2 contains (*a*) technical information classified under the following headings: (1) raw materials, (2) mining, (3) ceramic products, (4) preparation, (5) shaping, (6) drying, (7) firing, and (8) glazes; (*b*) a detailed description of the mining and preparation of raw materials for use as binders in mortar. A chapter is devoted to patent law followed by tables of molecular weights, melting points, heat values of fuels, etc. A list of trade publications for the building industry and technical and trade organizations, both domestic and foreign, followed by a very complete list of domestic sources of supply for raw materials and equipment of all kinds arranged for quick reference is given. F.A.W.

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Vol. 9 **May, 1930** **No. 5**

EDITORIAL

COÖPERATION IN THE HEAVY CLAY PRODUCTS INDUSTRIES[1]

Producers of brick, structural tile, sewer pipe, drain tile, conduits, roofing tile, and terra cotta have, in many respects, the same problems differing most largely in the means of forming the ware and in selecting and preparing the clays to develop the specified qualities required by each of the products. The variations in the clay selections and in the preparations for each of the types of heavy clay ware are no more than is frequently found necessary at a brick plant where they are producing a variety of brick types and a variety of decorative effects on brick.

In other words, the technical problems of production differ but little in the various heavy clay ware plants. When we compare two such extremes as drain tile with electrical conduit, common brick with terra cotta, quarry or roofing tile with paving brick, we recognize a vast difference in processing details as well as in products; yet in those plants where they are employing the best and most economic methods and where they are striving to produce the best quality of product from their available clays, the differ-

[1] Presented by Ross C. Purdy before the Annual Meeting of the Structural Clay Tile Assn., Columbus, Ohio, February, 1930.

ences between the manufacturing methods and even the differences in the products are not great. Generally, in plants not progressive, the largest differences are due to differences in degrees of slovenliness and lack of applied information.

An increasing number of makers of common brick are making products of facing brick quality and some structural tile and face brick makers are beginning to produce terra cotta. Generally it is easier for the face brick maker to produce common brick; for the conduit or terra cotta producer to make structural tile; the sewer pipe maker to produce drain tile than it would be to reverse this order of adaptability. This is true in part because of the difference in clay requirements, but in a large part to a difference in skill and knowledge requirements.

These differences in skill and adaptability once were much greater than at present. Economic influences are forcing greater skill and knowledge, as well as the use of more suitable clays into the simplest of ceramic manufacturing. The clay industries are not so different in materials and in processing as their different products would lead the uninformed to believe. It is now necessary to give to the making of the simplest and most crude product that same degree of skill that has been required in making the more complicated and finer products. The researches made under the direction of Geo. A. Bole, at the Roseville branch of the Ohio State University Engineering Experiment Station, are of as much value to the producers of abrasive wheels as they are to the makers of structural tile. There is a leveling, in contradistinction to specialization, in the art, science, and technology of heavy clay ware production.

This decrease in specialized differences in the production of heavy clay ware results naturally from the increased dispersion of technical knowledge. It is being reflected in the school curricula. Physics and chemistry, mechanics and electricity, ceramics and metallurgy are verging and some day will not be specialized to the extent of maintaining separate departments and having wholly different curricula. The ceramic engineer of today should be a mechanical and electrical engineer with specialization in ceramics. The ceramic scientist and technologist should be a chemical engineer with specialization in ceramics. The plant manager for brick and structural tile plants should be a trained engineer, mechanical, electrical, civil, or ceramic, who has made a special study of clays, clay working, and firing.

The task of the ceramic engineer and of the technologist does not cease with making products having definite properties. His task extends to determining what properties his products must possess to most successfully serve the purposes for which they are purchased. It is necessary that he study the influence of his clay admixtures, methods of preparation, and of forming, drying, and firing ware, on the quality of his products. This is as

true in brick and structural tile as it is in refractories, abrasive wheels, or electrical porcelain.

The ceramist should study the possible uses which his company's products could serve. He should know in detail the requirements which his products must satisfy.

Furthermore, it is up to the ceramist to know how his products should be used. The structural tile maker should know why his product has failed and by what means the service of his product could be improved. This, in part, is the task of the salesman but the ceramic technologist must serve the salesman as in the past he has served the works manager.

To be specific, structural tile, according to engineers who know, has ceased to be used for floor constructions because the structural tile manufacturers have not studied structural floor problems. Structural tile has not a good rating as a load bearing masonry because structural tile producers have not realized that this is their problem: that they must produce tile and have test and service data compiled that will command the approval of architects and builders. Structural tile, so some architects state, will not successfully take plaster because all clay tile effloresce. "Tile walls leak air and water; they are not good insulators against weather and they admit air so that hollow tile buildings are difficult to heat."

You believe that such accusations are not fair, and I agree with you. We cannot, however, deny that they are based on sad experiences. The man who paid for a structural tile building, the architect who designed it, and the contractor who built it blame the tile for the wet and cold walls. Have you convincing justification for your tile in such instances? You could and should have.

Cost of clay masonry constructions have increased and they have become less satisfactory. Why? My answer is that we have not studied masonry construction. The structural tile producers have fought their blood brothers, the face and the common brick makers, before code committees. What are we doing to prevent those poor masonry constructions for which tile and brick are unjustly blamed?

As surely as are the problems of production quite similar and growing more nearly the same, so are the merchandizing problems of masonry brick and tile. We are behind because we have always had a market for our products and we were not concerned about for what or in what manner they were used. We have neglected to use our state university testing facilities. We have failed to interest the professors and students in our state university departments of architecture and engineering. We have let producers of competitive products monopolize the university testing facilities. We have, comparatively speaking, been idle while manufacturers of masonry products other than clay have used our federal, state, county, and city facilities for demonstrating the merits of their products;

building up "unprejudiced" data on the "exceptional merits" of their products for construction purposes. We have for too long a while assumed that brick and tile were superior to all other building material from every possible standpoint.

To my mind here are the facts. Our brick and tile are badly placed in masonry walls. They are poorly and extravagantly laid. Engineers and architects have been engaged in studying other materials, hence ours are "out of sight and out of mind" of the army of engineers and architects which is being graduated each year and which has been graduated during the past several years into the building professions.

We must study and have others study the masonry problems of producing walls of brick and tile that will not scum, that will not allow water and air infiltration, that will carry loads, and resist fires.

I am not saying that sporadic tests and studies have not been made. They have been and are being made. My point is that we have failed to impress the contractor, architect, and purchasing public. We have a large neglected program of product studies and studies of product use which must be made if we are to bring our products back into the preferred class.

The merchandizing problems of face brick, of common brick, and of structural tile are very much if not almost exactly alike. There is no sense in having separate trade associations for each of these types of clay building material. Each is appealing to the same architect, contractor, and ultimate purchaser. Each is appearing before the same commissions and code committees. Each knows that for certain purposes the other fellow's product is most suitable. There are distinct uses for which face brick, common brick, and structural tile will respectively best serve.

Yet what have we. A three-cornered fight that benefits no one group other than the common competitors.

We have a problem now up for consideration, that of a "standard masonry unit." The makers of window frames asked the Simplified Practice Department of the Department of Commerce to call a meeting to standardize masonry openings. The AMERICAN CERAMIC SOCIETY had for a long while been studying how to correct the horribly botched brick and tile masonry constructions which we could see on every hand. The idea of a standard masonry unit was evolved. We had this so far along as to have it in the form of a paper written by Fred T. Heath[2] when we by chance heard of this masonry opening conference.

We sent preprints of the Heath paper to the invited conferees and attended the conference with the result that it was determined that masonry opening standards should be based on standard masonry units in clay, sand-lime brick, cement, and stone. It was further developed that all, other than brick and structural tile, were custom made, not stocked, hence

[2] *Jour. Amer. Ceram. Soc.*, **12,** [10], 605–39 (1929).

the entire standard masonry unit question rested fundamentally with brick and structural tile producers.

Can we get the face brick, the common brick, and the structural tile associations to collectively consider this question? There is no reasonable excuse for three associations not acting in unison as one body with the AMERICAN CERAMIC SOCIETY on this question of standard masonry unit size. This is not the place to discuss the question of a standard masonry unit but it is the place to state that these three blood brothers should act on it with the AMERICAN CERAMIC SOCIETY as one body.

Divided we are. We are spineless in our representations before federal and state organizations. We are not obtaining from the public financed and operated research institutions our proportionate share of the research facilities. Our competitors are getting their whole share and are using in addition our share because we are too weak too demand our own. We are paying our share of the upkeep and operating costs of these public institutions. We are not getting our share of the benefits.

If the brick and structural tile associations were coöperating with the sewer pipe and terra cotta associations before code committees, the sewer pipe would lose fewer contracts to cement, and the terra cotta to cut stone, hence they would be too busy to be competing with you. The potter, the glassmaker, and the iron enamel man could help you and you could help them. What a force the ceramic industrialists would be if they were not so antagonistically divided. Our highways would be paved with brick and the plants making pavers would be withdrawn from competition with the building brick and structural tile plants.

This is a plea for coöperation in the clay industries.

SOME OPERATING PROBLEMS IN CLAY MINING[1]

By H. E. Nold

ABSTRACT

Actual problems, the cause and possible solution are described. Calculations are given showing the economies of good drainage, well upkept equipment, and sane management of clay mines. Observations show that clay is wasted and mining hazardous and unnecessarily expensive in several of the clay mines examined. Recommendations are made.

Introduction

During the past three years the writer has visited almost every underground clay mine in the state of Ohio. He has continued his studies of clay mining in Ohio by visiting some of the mines a number of times and by keeping in contact with a number of superintendents and observing and discussing their operating problems.

Water is present in practically all the underground clay mines in Ohio, although the actual inflow is generally not large. In spite of only moderate amounts of water to handle, the majority of the mines are distinctly muddy and consequently the tracks are usually in poor condition, frequently slipping and sliding in the mud and water. It is a frequent occurrence, along these muddy haulageways to find that the posts have pierced into the soft, muddy bottom, and due to lateral pressure caused by the pillars slipping off near the top and sliding down against the posts, it is not unusual to find that the posts have been forced in at the bottom, thus narrowing the haulage ways and increasing the difficulties of effective drainage. This movement of the posts also allows a movement of the roof and is frequently followed by roof troubles.

In this paper the writer will discuss drainage, transportation, and timbering and will attempt to show the inter-relation of them and to point out some possible operating economies.

Drainage

Effective and economic drainage of a clay mine is difficult without certain basic information about each mine. The principal items of information that are necessary for planning the mine drainage are (1) information regarding the quantity of water to be handled, (2) the location of the main inflows, (3) the variation of the water with the seasons (if any), (4) the corrosive action of the water on pipes and pumps, and (5) the contours of the mined-over areas and as much of the unmined area as may be possible from prospecting data.

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Heavy Clay Products Division). Received Nov. 2, 1929. Also presented at the Fall Meeting, American Refractories Institute Division of the American Ceramic Society, Columbus, Ohio, September, 1929.

The contours of the mine bottom or floor are as essential to the economical drainage of a mine as knowledge of the amount of water to be handled. A study of the contours will frequently show where a pump can be replaced by ditches or a syphon with a consequent saving in operating costs. In one instance, due to lack of contours, the pumping system in the mine was recirculating about one-half of the water in the mine instead of discharging it so that it would flow to the surface through out-crop openings as was intended. In another case, the study of the contours on the map enabled two pumps and a night pumper to be replaced by two syphons. When last seen these syphons had operated constantly for three years with practically no attention. The engineer can take the data necessary to place the contours on the mine map, at small expense, providing extensions are made each time he surveys the mine.

The maintenance and cleaning of ditches is somewhat difficult in many clay mines due to the tendency of the ditches to fill up by settling and by the slipping off of the sides. This trouble is frequently made much greater than necessary by putting in ditches with too flat a gradient, by not making them deep enough to drain the track, and by improperly placed sumps and sumps so shallow that the ditches must at times function as a sump or reservoir for the water. A careful study of the drainage problem with the consequent properly placed ditches, sumps, and pumps has recently enabled one clay mining company in Ohio to reduce drainage costs and has changed a wet muddy mine into a dry dusty one with much improved haulage conditions as a natural result.

Acid water is a frequent source of trouble in mines. It eats out the pipes and corrodes and destroys pump parts. To counteract this the manufacturers of mine pumps have developed acid-resisting alloys for use as pump parts. These, while having a higher first cost than ordinary parts, are a good investment due to their longer life. In cases where the acidity of the water is so great that the life of water pipes is only a matter of months, the use of wooden pipe has been found profitable. Wooden pumps have also proved profitable in some instances.

Haulage

Wet rails, muddy and frequently unballasted track, rough and crooked track, light rails, ties too far apart, poorly maintained rolling stock, no grading of haulage ways, and track gages not standard are all items that make for high cost of transportation in a rather large proportion of our clay mines. In one mine visited recently the mud was so deep on the tracks in the main haulage way that it was cut off by the axles of the cars and consequently a good sized mule was able to pull only one rather small car on practically level track where three of the same cars would not have been a large load on good track.

At another mine the water along a considerable extent of track was over the axles. Grease seemed to be an unknown quantity as far as car lubrication was concerned and the bearings were so worn that a lead pencil could be inserted on some cars between the axle and the wheel.

Corduroyed tracks (either of plank or of split timbers) virtually floating on the mud are not an unusual sight. In one mine with a capacity of less than 300 tons per day, they had 15 derailments recently, due to poor track, in one day with animal haulage.

These are all facts and most of them of common occurrence. They all operate to make haulage expensive. In discussing these conditions with mine foremen and superintendents the writer has been told repeatedly that such conditions are inherent in clay mining and cannot be changed except at prohibitive cost.

The maintenance of good track and haulage equipment always pays. As an example of what can be done, the experience of one company mining clay in Ohio can be cited. This company graded their main line tracks by filling swales and cutting down the high places. Then they put in heavier rails on good ties, properly spaced, with good ballast and with careful aligning and surfacing. An effective system of drainage was put into operation and is being maintained. The result is that a once muddy mine is now practically dry on the haulage ways and at places is dusty. Their engineer reports that they are now transporting clay underground at a cost per ton mile less than that in 1913 and this in spite of increased labor and materials costs.

Maintenance of Haulage Equipment

It pays to keep equipment in good condition as much in the mine as in the manufacturing plant. Lack of grease in the car wheel bearings means high rolling friction and badly worn bearings; as a result the wheels will soon not run true to the track gage and derailments follow. Instead of caring for the wheel bearings and washering the wheels out to gage when they become worn, some superintendents have the habit of attempting to cure the trouble by narrowing the track gage. This practice has resulted in the following conditions in the Ohio clay mines. The standard gages generally recognized are 30, 36, 42, and 44 inches. Out of 80 mines on which this information was obtained four have 30-inch gage, 37 have 36-inch gage, 10 have 42-inch gage, and one has 44-inch gage. The remaining 28 mines have various odd gages varying from 28 to 39 inches and including every inch between these limits. One company has three different gages in four mines, another has four gages in four mines, two others have two different gages in three mines each, etc.

Such conditions mean that any rolling equipment bought must be built special to fit the odd gages and is consequently more expensive. A disadvantage of a company having different gages in their several mines is

that they cannot move equipment from one mine to the other and that a greater stock of repair parts is necessary to avoid extended delays in case of breakdowns.

It should be emphasized that this whole haulage problem is intimately related to proper drainage. Good track is practically impossible to maintain without proper drainage. You cannot hold track in line or keep it surfaced if the foundation is wet puddled clay.

Haulage Resistances

The drawbar pull necessary to move a loaded car or string of cars at a uniform speed on a straight, dry, level track with well cared-for plain bearings is about 30 pounds per ton of weight of car and contents. With roller bearings this resistance is considerably less, according to some tests being as low as 15 pounds per ton although for estimating purposes 20 pounds is probably a better figure to use. With muddy, rough, and crooked track the resistance increases and is frequently 40 pounds per ton and in some cases even more. In other words the drawbar pull is increased 33% or more if the track is in poor condition and the haulage capacity of the locomotive or animal used is proportionally decreased.

Effect of Grades

The drawbar pull necessary to pull a load up a grade amounts to 20 pounds per ton of load per per cent of grade. Thus the pull necessary to move a one ton load on good level track is about 30 pounds. To move the same load up a 2% grade the pull is 30 pounds plus two times 20 pounds or 70 pounds per ton of load. Stating it in other words, pulling up a 2% grade reduces the haulage capacity of a locomotive or horse by about one-half. The mine superintendent, however, states that he has no control over grades, that they are determined by the lay of the deposit. This is true in part only. It is true that the deposit has an average normal dip which cannot be changed although grades on it can frequently be improved by changing the direction of the mine workings somewhat. In practically all Ohio clay mines there are local rolls and swales with steeper grades than the general dip of the deposit and frequently in the opposite direction. A study of the haulage way profiles will frequently show where some grading will materially reduce or even eliminate grades and thus cheapen haulage.

Roof Support

The fire clays of Ohio are all coal measure clays and therefore the mine roof is frequently coal or, if the coal is absent or is mined, the roof is the rock, usually shale, lying above the coal. The roof problem, as far as the rock is concerned, is therefore the same as in the coal mines.

It is not the function of mine timbers to support the overburden. To

illustrate, assume that posts are spaced 5 feet in each direction in the excavated part of the mine and assume a cover of 200 feet. The rocks, mostly shales, sandstones, and limestones, comprising the cover will, on the average, weigh at least 150 pounds per cubic foot. With a 5-foot spacing each post, if supporting the overburden, would have to bear the weight of a column of rock five feet square and 200 feet high. Such a column would contain 5000 cubic feet of rock and would weigh 750,000 pounds. The ultimate strength of a straight white oak post, as used in the mines is about 4500 pounds per square inch. To support the overburden here, would therefore require a post with 167 square inches cross-section or about 13 inches square and this would allow no factor of safety. With a normal factor of safety about five times this amount of timber would have to be used to support the overburden. Such timbering is obviously economically impossible.

The real use of supports placed in the mines is to support the first few feet of rock immediately above the clay, to keep it from sagging or breaking and thus prevent the development of roof falls and the exposure of new strata to the atmosphere, with the roof troubles consequent to such exposure. The overburden must be supported on the pillars and if these are of insufficient size a squeeze will result.

The desire to save in the first cost of props or posts is a frequent cause of roof trouble and of much increased ultimate cost of timbering. The mistake is in buying soft wood, crooked and knotty posts and posts which are too small in diameter in proportion to their length. The ability of a post to resist roof pressure decreases as the ratio of the length in inches, to the least diameter in inches, $1/d$ increases. For example, a good block of white oak set on end has an ultimate strength of about 5000 pounds per square inch and a safe working strength of about 1000 pounds per square inch, while a post ten times as long as its least diameter has an ultimate strength of about 4470 pounds per square inch and a safe working load of 895 pounds per square inch. If the length is 15 times the least diameter the values are reduced to about 4000 pounds and 800 pounds. In terms of posts, a well-seasoned straight white oak post 10 feet long, set vertically has a safe working strength in proportion to its $1/d$ as follows:

l (in.)	d (in.)	$\frac{l}{d}$	Safe Working Load (lbs./sq. in.)	Tons per post
120	15	8	928	71.4
"	12	10	895	50.6
"	10	12	859	33.7
"	8	15	804	20.2
"	6	20	714	10.1

This without further comment explains the trouble so many mines are having to hold the roof. The trouble is more often too small posts than not enough posts.

As before mentioned two other timbering troubles are common in our clay mines. They are posts piercing into the bottom and thus letting the roof down and posts squeezing in at the bottom due to lateral pressure. Both these troubles are, in the majority of cases, closely associated with and are generally caused by a soft bottom which in turn is due to poor drainage. In most clay mines the bottoms are not soft if not water soaked, and they need not be areas of mud and water if properly drained. In the exceptional mine where the bottom is soft, even when reasonably dry, it may pay to use sills with all three-piece timber sets.

Summary

(1) Mine drainage, haulage, and roof support are intimately inter-related and the essential to good cheap haulage and roof support is good and adequate drainage.

(2) An economic system of drainage cannot be installed and operated without a knowledge of the quantity, quality, and location of source of the mine water.

(3) A mine map with contours of the mine floor is a paying investment when used to work out the drainage and haulage of the mine.

(4) Sumps should be deep enough so that ditches need not serve as water reservoirs and so that ditches can be made deep enough and with enough gradient to do their work.

(5) Wet, muddy, crooked, and rough track is a poor investment. The track should be drained, ballasted, surfaced, and aligned.

(6) Main line haulage track should be graded.

(7) Good track pays dividends in reduced haulage costs.

(8) Rolling stock should be well oiled and kept in repair.

(9) Attempts to save money by buying poor quality and small diameter props defeat their own end. Small posts increase cost of timbering.

(10) Proper drainage will help solve the roof support problem by giving the posts a firm foundation upon which to set.

(11) A well-drained mine, with good tracks and well timbered is the cheapest mine to operate.

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CONSTRUCTION AND OPERATION OF A SPECIAL DIAMOND CORE DRILL FOR EXPLORING SHALE DEPOSITS[1]

By V. W. Boeker

Introduction

Rudolph Leschot, a French engineer, was, in 1864, the first to design and use a diamond drill. He employed black diamonds for drilling through rock. Since then the principles of diamond drilling have changed but little but the drilling machines have been greatly improved.

[1] Presented at the Annual Meeting, American Ceramic Society, February, 1930, Toronto, Ont. (Heavy Clay Products Division). Received March 13, 1930.

A modern standard diamond drill consists essentially of a power-driven unit. Gears transmit a rotary speed of from 250 to 350 revolutions per minute under a downward pressure to a line of hollow steel drill rods. Attached to the line of rods is a core barrel at the end of which is attached an annular steel bit. This steel bit is set with six to eight black diamonds averaging in size from about 1 to $4^1/_2$ carats each. Cutting is accomplished by the rotating action of this bit. A cylindrical core is produced which passes into the hollow core barrel.

When the drill is withdrawn from the hole the core is clamped tightly by a special core spring, attached to the bottom of the core barrel, which breaks the core from the native rock. The drill is withdrawn at desired intervals and the core removed.

When drilling, the bit is cooled by water pumped through the hollow rods. This circulating water washes the cuttings from the drilling to the surface.

Standard Drill Fails to Meet Fully Shale Prospecting Requirements

Diamond drills are usually employed for deep drilling. In such cases the drill is carefully set up and remains in one location for a considerable period of time. A derrick is usually built up at the drill location and made as high as conveniently possible to facilitate pulling the rods from the hole. In shale prospecting where the holes are usually comparatively shallow, the drill has to be moved frequently. In such cases this method of setting up the drill would be very costly.

It is the general practice in diamond drill work to use a "fish-tail" bit through the clay, gravel, and other loose material; to wash such material out of the hole, and dispose of it. The core drill is not started until solid rock is reached. In prospecting for shale, this is most unsatisfactory. Knowledge of the nature of the material comprising the overburden is as essential as knowledge of the amount of overburden present. Very often a careful investigation will prove that this overburden may also have industrial value.

Diamond drill bits are made in a range of standard sizes. These bits are designed to recover cores from approximately one to two inches in diameter. This is much too small for use in prospecting for ceramic materials. The cores recovered from such drilling should be large enough to supply generous samples for careful physical as well as chemical tests.

It was found that operators of such drills and manufacturers of diamond drilling equipment were very reluctant to depart from standard equipment and practice. A manufacturer of diamond drilling equipment was found who would make a special drill modified to meet the particular requirements of shale prospecting. To the E. J. Longyear Company, Minneapolis, Minn., largely belongs the credit for the success of this undertaking.

Design of Modified Drill

The drill selected was of the screw-feed type. This type is easier to handle than the hydraulic feed drill and is equally satisfactory for shallow holes.

The power unit used was a four cylinder, marine type, gasoline engine. While steam power is generally preferred for diamond drilling on account of its flexibility and power performance, it is unsatisfactory for drilling shallow holes where moves are frequent.

The drill, engine, and necessary water pumps were all mounted on a heavy truck. Both the drill and the water pumps were chain driven directly from the extended shaft of the engine. This made a compact, light, and easily portable outfit which could readily be moved from one location to another with a minimum loss of time in dismantling and setting up operations. (See Fig. 1.)

As this drill was to be used for shallow holes only and the rods could therefore be pulled in short sections, a tripod was used in place of a derrick.

FIG. 1.—Portable diamond drill.

It was decided to use a bit of such size as would recover a core four inches in diameter. The making of so large a bit offered no special problems. To fully cover the cutting face it was found necessary to set ten diamonds in this bit in place of the usual six or eight. A special core barrel and core lifter were built to conform to the size of the bit.

In standard diamond drilling practice the drill rods used are the same diameter as the bit. In this instance it would have been impractical and extremely expensive to build rotating and feeding machinery large enough to fit the greatly oversize rods which would have had to be used had this practice been followed. It was therefore determined to use standard two-inch diameter rods in connection with the much larger core barrel and bit. While this system might be found impractical in deep drilling, due to excessive deflection of the small rods in a large hole, it was found to be thoroughly satisfactory for shallow drilling.

Operation of Drill

The drilling was done by a crew consisting of one drill runner and one helper. At the location of a drill hole the heavy truck was blocked in place, the tripod raised and centered over the drive rod of the drill which had been set exactly over the location of the hole.

It is not possible to form a core of soft materials, such as clay, with the diamond drill and its accompanying circulating water. As it was desired in this instance to recover a core of all materials passed through, a heavy four-inch diameter wrought iron pipe, ground sharp at one end and serving

as both cutting edge and core barrel, was substituted for the diamond drill until solid material was struck. A 200-lb. hammer and a slip drive on the winding drum of the hoisting mechanism served as a pile driver to force this iron pipe through the overburden. As no water was used, the core stuck tightly in the pipe and was satisfactorily recovered. While this system is slow and tedious, it has the advantage of being positive, giving an accurate log of the overburden and recovering all of the core. Figure 2 shows the driving operation.

FIG. 2.—Diamond drilling.

When solid material was struck, driving had to be abandoned. The hole was then cased down to the solid material to keep the overburden from being washed into the hole by the circulating water. The casing was thoroughly washed out before drilling proceeded.

When the casing was thoroughly clean, the bit, core shell containing the core lifter, and core barrel were connected and lowered into the hole through a safety clamp set across the top of the casing. This clamp gripped and firmly held the core barrel about one foot from the upper end. To the exposed end a ten-foot section of drill rod was screwed at the other end of which a hoisting plug was attached. The line of rods and the core barrel were then lowered into the hole by means of a brake on the hoisting drum until again gripped in the safety clamp. This operation was repeated until about a rod's length from the bottom, when the feed mechanism with a rod through it was swung into place and this rod connected with those in the hole. The pumps were then started and the bit slowly run down by the feed mechanism until it engaged solid material and drilling was under way. Figure 3 shows the drill in operation.

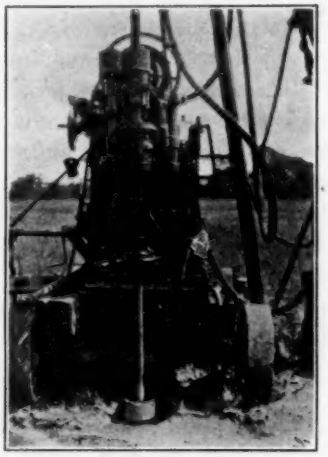

FIG. 3.

When the drill had run down the distance equal to the length of the core barrel, drilling was stopped. The pump was kept running a few minutes to wash all the cuttings out of the hole. After the rods and core chamber containing the core were withdrawn by reversing the operations described for lowering them, the bit and core shell were unscrewed from the bottom of the core chamber and the core removed.

Figure 4 shows the operator just beginning to remove a core. The bit and core shell are also shown.

All of the above operations were repeated until the desired depth had been reached.

FIG. 4.—Removing core from chamber.

Operating Data and Results

It is realized that the distance drilled per working day will vary with the character of the material in which the bit is working, the ability of the operator, and the average depth of the holes drilled. It is also realized that the time consumed in moving and setting up the drill will vary with the topography of the land and the distance between drill holes. Nevertheless, as the diamond drill is used so rarely in prospecting for ceramic materials and since the size of this drill is so unusual, the following general operating data may be of interest:

TABLE I
POSSIBLE OPERATING SPEEDS WITH FOUR-INCH DRILL

Material	Distance per day (ft.)	Method
Clay, sand, and gravel	7–15	Driving
Soft shale	10–20	Drilling
Hard shale	25–40	"
Sandstone and soft limestone	20–30	"

TABLE II
OPERATING DATA

Number of holes drilled	20
Variation in depth (ft.)	27–76
Total distance drilled, all holes (ft.)	1200
Actual working days required	69
Average distance drill per working day, including time for moving and setting up drill, and other minor delays (ft.)	17½

It must be borne in mind that these data are subject to the variations given above.

The results obtained by the use of this equipment were highly satisfactory for the purpose intended. The cores recovered gave an absolutely clear, accurate, and permanent record of the materials passed through. These cores were large enough to furnish ample samples for laboratory tests of the materials.

While this method of drilling is more expensive than some other methods, it is considered far more satisfactory than any other method that could have been used. Drilling of any kind is expensive and unless an absolutely complete and thoroughly reliable record is obtained the time and money put into it are spent in vain.

RICHARDS BRICK COMPANY
EDWARDSVILLE NATL. BANK AND TRUST CO. BLDG.
EDWARDSVILLE, ILL.

ACTIVITIES OF THE SOCIETY

MINUTES OF THE EXPOSITION AND CONVENTION EXECUTIVE COMMITTEE, AMERICAN CERAMIC SOCIETY, CLEVELAND, OHIO

The second meeting of the Northern Ohio Local Section, AMERICAN CERAMIC SOCIETY, was held at the Cleveland Hotel at 2.00 P.M., Saturday, March 15. The meeting was called to order promptly by J. M. McKinley, Chairman. Visitors to the meeting were W. H. Eisenman and two of his assistants, Mr. Ohlson and J. E. Donnellan.

After some discussion on the coming Exposition, in which Mr. Eisenman gave his view and plans in case he were engaged as manager, Mr. Purdy moved and Mr. Spencer seconded that the Exposition be open from Monday to Friday inclusive, of the Ceramic Week and that there be four daily technical sessions from 9:30 A.M. to 1:30 P.M. on days including Tuesday to Friday and committee meetings on Monday. This motion was carried.

In further discussions of the Exposition, it was decided that by demanding a small percentage of the booth fee from exhibitors at the time of their contract no underwriting from individuals would be necessary. To take care, however, of the initial fee of $500.00 to be paid at the time of the signing of the contract for the Auditorium, the following motion was made by Mr. Spencer and seconded by Mr. Fenno.

"Moved that the AMERICAN CERAMIC SOCIETY sign the contract for leasing the Public Auditorium and advance the necessary $500.00 for which the SOCIETY will be reimbursed from advance booth rentals or by the local Cleveland group in case booth rentals are not sufficient." Motion was carried.

Charles Spencer was named as Vice-Chairman of the local Executive Committee, and Geo. W. Denison as its Treasurer.

Mr. Eisenman presented a tentative budget of expenditures for the Exposition which was discussed, after which Mr. Spencer moved, and Mr. Moranty seconded, that Mr. Eisenman be engaged as Exposition Manager. This motion was carried.

Mr. Spencer moved, and Mr. Moranty seconded, that Mr. Eisenman be empowered to conclude all arrangements concerning the leasing of the Public Auditorium, and forward the contract to Columbus to be signed by the AMERICAN CERAMIC SOCIETY.

A motion was made and properly carried that technical meetings and noon luncheons should be held at the Cleveland Auditorium.

The problem of selecting a hotel was generally discussed, but a decision was not reached. It was decided that the Committee should consider this problem at its next meeting.

After some further discussion and examination of the proposed layout of booth spaces, the meeting adjourned.

Personnel of the Executive Committee

The personnel of the Executive Committee is as follows:
J. M. McKinley, *Chairman*, North American Refractories Co.
C. D. Spencer, *Vice-Chairman*, National Lamp Works of General Electric Co.
G. W. Denison, *Treasurer*, Ohio Clay Company
R. P. Stoddard, Common Brick Manufacturers Assn.
C. L. Sebring, Sebring Pottery Co.
R. D. Landrum, Titanium Alloy Mfg. Co.
R. G. Cowan, Cowan Pottery Studio
H. E. Ebright, Ferro Enameling Co.
The Finance Committee is as follows:
G. W. Denison, *Chairman*
C. D. Spencer
J. M. McKinley

FRENCH CERAMISTS TOUR IN AMERICA

Ceramic Group in New Jersey

Wednesday April 9

New York. Met at Pier by George Simcoe and Donald Edgar, Edgar Brothers Company, Metuchen, N. J.

Met at Pennsylvania Hotel by G. H. Brown, F. A. Whitaker, and E. V. Eskesen.

Ceramic group motored to Woodbridge in automobiles provided by George Simcoe, E. V. Eskesen, and F. A. Whitaker. Luncheon at Middlesex Hotel, Woodbridge. Received at this luncheon by the Hon. Wm. A. Ryan, Mayor of Woodbridge, N. J., and Hampton Cutter, F. R. Valentine, R. L. Clare, J. M. Kreger, O. E. Mathiasen, E. V. Eskesen, G. H. Brown, F. A. Whitaker, and Geo. Simcoe.

3:00 P.M. Visited factory of the Federal Seaboard Terra Cotta Corporation, Woodbridge, manufacturers of architectural terra cotta, E. V. Eskesen, President.

French Ceramists Touring United States Plants

Front row (left to right): D. J. Fisher, Roger Hecq, Pierre Munier, Eugene Labecque, Robert Le Heron, Guido Gerster, Edouard Fenal. Top row: T. A. Bean, F. S. Thompson, G. H. Brown, Maurice Delassus, Rene Vallot.

4:15 P.M. Visited plant of Woodbridge Ceramic Corporation; J. M. Kreger, Manager; manufacturers of porcelain (all clay) sanitary ware.

5:00 P.M. Left Woodbridge via automobile arriving at the Woodrow Wilson Hotel, New Brunswick, at 5:30 P.M.

7:00 P.M. Dinner, Woodrow Wilson Hotel. Present at dinner: Mr. and Mrs. Douglas J. Fisher and son, Sayreville, Mr. and Mrs. F. A. Whitaker, Prof. and Mrs. G. H. Brown, Miss Susan White, C. W. Crane, E. V. Eskesen, and R. P. Hazlehurst.

Thursday April 10

8:00 A.M. Party met at Hotel by D. J. Fisher, G. H. Brown, and F. S. Thompson. Motored to Keyport, N. J. and visited plant of Architectural Tile Company, A. Christian, President; manufacturers of wall tile.

10:00 A.M. Motored from Keyport to Metuchen and visited office and laboratories of Edgar Bros. Company. Received by L. E. Riddle, Jr., Souvenirs.

11:00 A.M. Returned to New Brunswick. Met at Woodrow Wilson

Hotel by Fred Sutterlin and J. Guild Carter. Party taken by automobile to Princeton for luncheon at the Princeton Inn, under arrangements by F. W. Dinsmore. Following luncheon party motored about Princeton University Campus and then to Trenton.

3:00 P.M. Arrived at plant of Imperial Porcelain Wks., Trenton, B. B. Dinsmore, President; manufacturers of high and low tension electrical porcelain.

4:00 P.M. Visited plant of Scammell China Co., received by the President, D. W. Scammell, Matthew Scammell, and Fred Sutterlin. Manufacturers of high-grade hotel china.

5:30 P.M. Arrived at Stacy-Trent Hotel, Trenton.

7:00 P.M. Dinner at Stacy-Trent Hotel under auspices of Trenton ceramists. Present: Hon. Frederick W. Donnelly, Mayor of Trenton; Professor A. G. Cameron, French Dept., Princeton University; J. M. Gilfillan, Matthew Scammell, G. H. Brown, J. A. Williams, F. W. Dinsmore, Fred Sutterlin, F. A. Whitaker, Harry A. Brown, Lyman Leavitt, Paul Teetor, Paul Berryman, and John C. Wilkes. Program included an address of welcome by Mayor Donnelly and presentation of the key of the City of Trenton, and an address by Professor Cameron.

Friday April 11

A.M. Visited plants of Lenox, Inc., Harry A. Brown, President, manufacturers of fine china.

Visit to plant of Robertson Art Tile Company, Morrisville, Pa., D. P. Forst, President; manufacturers of floor and wall tile.

Noon. Luncheon at Stacy-Trent Hotel under the auspices of the Trenton Chamber of Commerce.

P.M. Visited plant of Trenton Potteries Company; J. A. Campbell, President. Manufacturers of all types of sanitary ware.

Visited Thos. Maddock's Sons Company plant; A. M. Maddock, President.

Visit of Glass Group, French Ceramists, South Jersey

Wednesday April 9

This party left New York for Philadelphia in the evening and spent the night at the Benjamin Franklin Hotel.

Thursday April 10

8:30 A.M. Met at Hotel by Herrold Thropp, Thos. Graham, P. D. Thropp, Jr., V. V. Kelsey, and W. Seger. Motored from Philadelphia to Bridgeton, N. J.

Luncheon at Cumberland Hotel.

P.M. Visited plants of Owens-Illinois Glass Company (manufacturers of glass bottles) at Bridgeton; Tavern Rock Sand Company, Millville (glass sands).

7:00 P.M. Dinner at Hotel Cumberland. Guests of local glass manufacturers.

Friday April 11

A.M. Visited plants of Vineland Flint Glass Company, Vineland (manufacturers of scientific and art glassware). Kimble Glass Company, Vineland (manufacturers of scientific glassware).

Luncheon. Guests of Victor Durand at Vineland.

P.M. Visited plant of Whitall-Tatum Company, Millville (manufacturers of scientific glassware).

6:00 P.M. Returned to Hotel in Philadelphia by automobile.

The arrangements in South Jersey were made by Herrold Thropp, assisted by Thos. Graham, V. V. Kelsey, and Victor Durand.

NEW MEMBERS RECEIVED FROM MARCH 1 TO APRIL 1

PERSONAL

Frank R. Clark, 3870 Middleton Ave., Cincinnati, Ohio; Manager, The Edward Mfg. Co.

Cornelius Doorn, Robinson, Ill.; Industrial and Management Engineer.

John Louis Drake, Chief Engineer, Libbey-Owens Glass Co., Toledo, Ohio.

Charles O. Duevel, Jr., Asst. Chief Engr., American Thermos Bottle Co., Norwich, Conn.
Richard L. Harrison, 308½ Main St., Lafayette, Ind.; General Manager, Rostone, Inc.
H. O. Busch Jensen, 2506 Barclay St., Baltimore, Md.; Locke Insulator Corp.
Arthur A. Knox, Works Manager, Reliance Firebrick & Pottery Co., Barakar, P. O., India.
Ralph H. Martin, 7135 S. Seville St., Huntington Park, Calif.; Ceramic Engineer, Vitrefrax Corp., 5050 Pacific Blvd.
Rubert Monks, 128 Fraley St., Kane, Pa.; Annealing Engineer, American Plate Glass Corp.
H. D. Thweatt, Southwark Foundry & Machine Co., 703 United Bldg., Akron, Ohio.
Arthur Eric Jarvis Vickers, 27 Lily St., Wolstanton, Stoke-on-Trent, England; Chief Consulting Expert on Ceramics, The Imperial Chemical Industries, Ltd.

STUDENT

Harry Mahnken, Jr., New York State School of Clayworking and Ceramics, Alfred, N. Y.

Membership Workers' Record*

	PERSONAL		STUDENT
Wilbur F. Brown	1	Office	1
Elmer H. Ockermann	1	Grand Total	12
F. H. Riddle	1		
Jos. P. Rodgers	1		
F. W. Salisbury	1		
Dorothy A. Texter	1		
Office	5		
Total	11		

* Through a misunderstanding one member too many was credited to the Office last month. The correct total was 31.

ROSTER CHANGES IN MARCH

CORPORATION*

American Encaustic Tiling Co., Horace F. Crew (voter), Zanesville, Ohio. (Wm. McCoy (voter)).
Vitro Mfg. Co., George Blumenthal (voter), Pittsburgh, Pa. (Josef Volkommer (voter)).

PERSONAL*

Adams, L. A., Chicago Vitreous Enamel Product Co., 1407 S. 55th Court, Cicero, Ill. (Mansfield Vitreous Enameling Co., Mansfield, Ohio.)
Anderson, Robert J., 2195 Lincoln Ave., N. W., Lakewood, Cleveland, Ohio. (Fairmont Mfg. Co., Fairmont, W. Va.).
Barth, Victor R., 3306 Tarlton Ave., Chattanooga, Tenn. (26 Pearl St., Great Barrington, Mass.)
Brenner, R. F., Roessler & Hasslacher Chemical Co., Toledo, Ohio. (Owens-Illinois Glass Co.)
Brockmann, E. A., 526 East 4th St., Cincinnati, Ohio. (Roessler & Hasslacher Chemical Co., New York, N. Y.)
Daniels, C. O., Greendale Brick Co., 141 N. Front St., Columbus, Ohio. (Logan, Ohio.)
Dively, Geo. W., U. S. Refractories Corp., Mount Union, Pa. (Clearfield, Pa.)
Fuller, Donald H., Roberts & Mander Stove Co., Hatboro, Pa. (Bureau of Standards, Washington, D. C.)
Geller, R. F., 5425 Connecticut Ave., Apt. 311, Washington, D. C. (Bridesburg, Philadelphia, Pa.)
Glick, Wendell, 1761 Collamer St., E. Cleveland, Ohio. (Columbus, Ohio.)

* Addresses within the parentheses ( ) represent the old address.

McCoy, Nelson, Nelson McCoy Sanitary Stoneware Co., Roseville, Ohio. (Zanesville, Ohio.)
Moore, Richard Scott, Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh, Pa. (Homestead, Pa.)
Moran, J. J., 823 Park Ave., Vineland, N. J. (Philadelphia, Pa.)
Moranty, Adam F., Leeds & Northrup Co., 1941 Union Trust Bldg., Cleveland, Ohio. (1227 Union Trust Bldg.)
Morse, George T., 100 Woodbridge Ave., Metuchen, N. J. (Woodbridge, N. J.)
Musselman, John E., 472 E. 7th Ave., Tarentum, Pa. (Tiffin, Ohio.)
Nagle, J. A., Carling Tile Co., Macon, Ga. (30 Acton Rd., Columbus, Ohio.)
Reif, Richard E., c/o C. B. Stone, R. D. 3, Syracuse, Ind. (New Castle, Pa.)
Siegrist, Paul F., Blackmer and Past Pipe Co., 2801 Hereford St., St. Louis, Mo. (Mellon Institute, Pittsburgh, Pa.)
Spiker, John E., Hispano Moresque Tile Co., Lawndale, Calif. (Los Angeles, Calif.)

STUDENT*

Lane, Kenneth C., Route 1, Friendship, N. Y. (Wellsville, N. Y.)

These roster changes which are published each month may be checked against the complete Membership Roster which was published in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

PROGRESS REPORT OF TESTS SECTION OF THE STANDARDS COMMITTEE OF THE GLASS DIVISION[1]

(1) During the year there have been prepared standard samples of opal glass, high boron (12% B_2O_3) glass, and low boron (0.75% B_2O_3) glass. These are now being issued with provisional certificates by the Bureau of Standards.

(2) The analytical work on standard samples of flint fire clay, plastic fire clay, and argillaceous limestone is finished at the Bureau of Standards and these three new standards were ready for distribution on April 1.

(3) A sample of soda feldspar has been prepared, and this sample will probably be ready for distribution by June 1.

(4) By July 1, 1930, the Bureau of Standards will have available analyzed samples of the following ceramic materials:

Argillaceous limestone, dolomite, glass sand, potash feldspar, soda feldspar, fluorspar, soda-lime glass, lead-barium glass, opal glass, low-boron glass, high-boron glass, flint fire clay, plastic fire clay, three fired refractories running from 38 to 70% of Al_2O_3 and 20 to 50% of SiO_2, and bauxite.

The Tests Section will welcome suggestions as to other standard analyzed samples that are needed.

(5) No tentative or standard methods of analysis have been prepared during the year. Methods have been worked out for the determination of silica in the presence of fluorine and boron, and the determination of fluorine in ceramic materials. Numerous tests have been made of methods for the determination of boron, but no method has proved as reliable as the Chapin method.

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* Addresses within the parentheses ( ) represent the old address.
[1] G. E. F. Lundell, Bureau of Standards, Washington, D. C.

FIRST REPORTS OF ANALYSES OF FLINT CLAY, NO. 97

Analyst No.	SiO_2	R_2O	Al_2O_3	TiO_2	ZrO_2	P_2O_5	Fe_2O_3	V_2O_5	Cr_2O_3	CaO	MgO	K_2O	Na_2O	Loss on ignition
1	42.80	42.59	38.86	2.33	0.23	0.08	0.96*	0.040	0.091	0.10	0.26	0.54	0.37	13.32
2	42.89	42.55	38.46	2.44	0.26	0.30	0.953*	0.045	0.091	0.08	0.23	0.56	0.28	13.37
3	42.09	42.76	38.47	2.63			1.66			0.27	0.38	0.71(*h*)		13.96
4	42.87	42.72	39.01	2.40		0.087	1.22			0.20	0.32	0.32	0.11	13.60
5	42.88	42.35	38.54	2.28	0.046	0.05	1.34(*a*)	0.017	0.073	0.33	0.27	0.55	0.26	13.33
6	42.94	42.68	39.11	2.51		0.08	0.98			0.08	0.21	0.93		13.22
7	43.02	42.36	38.75	2.62		0.04	0.95			0.12	0.21	0.94		13.37
8	42.88	43.16	39.48	2.49			1.20(*b*) 1.23(*c*) 1.19(*d*) 1.16(*e*) 1.17(*f*)			0.06	0.23	0.18	0.19	13.53
9							1.13(*b*) 1.01(*c*) 1.18(*d*) 1.02(*e*) 0.96(*g*)							
Average	42.80	42.65	38.84	2.46	0.18	0.11	1.13	0.034	0.085	0.16	0.26	0.43	0.24	13.46
Tentative recommended value	42.85	42.60	38.80	2.35	0.25	0.07	0.98	0.043	0.085	0.10	0.26	0.55	0.32	13.34

* Separated iron by the use of H_2S in an ammoniacal tartrate solution; then determined it gravimetrically. See "The Analysis of Bauxite and of Refractories of High Alumina Content," by G. E. F. Lundell and J. I. Hoffman, Bur. Stand., *Jour. of Research*, July, 1928. (*a*) Rechecked value = 1.00%. (*b*) Combined oxides fused with pyrosulphate and reduced with H_2S. (*c*) Combined oxides fused with pyrosulphate and reduced with zinc. (*d*) Sample fused directly with pyrosulphate and reduced with H_2S. (*e*) Sample fused directly with pyrosulphate and reduced with zinc. (*f*) Combined oxides dissolved in HCl and reduced with $SnCl_2$. (*g*) Sample fused directly with pyrosulphate and titrated with titanous sulphate. (*h*) Result obtained by the use of the empirical factor 0.53. In addition to the constituents listed, two analysts have reported 0.04% of SO_3 and one analyst has reported CuO, MnO, and BaO; also a trace of MoO_3.

FIRST REPORTS OF ANALYSES OF PLASTIC CLAY, No. 98

Analyst No.	SiO_2	R_2O_3	Al_2O	TiO_2	ZrO_2	P_2O_5	Fe_2O_3	V_2O_5	Cr_2O_3	CaO	MgO	K_2O	Na_2O	Loss on ignition
1	59.17	29.15	25.50	1.42	0.044	0.09	2.04*	0.030	0.024	0.20	0.69	3.18	0.31	7.22
2	59.02	29.07	25.51	1.46	0.047		2.04*	0.023		0.17	0.67	3.27	0.24	7.26
3	57.64	29.75	25.27	1.72			2.76(*a*)			0.45	0.87	2.88(*h*)		8.56
4	58.83	29.09	25.44	1.35		0.091	2.21			0.27	0.91	2.75	0.38	7.72
5	59.09	29.24	25.75	1.32	0.032	0.064	2.04	0.017	0.022	0.32	0.77	3.10	0.26	7.18
6	58.88	29.44	25.69	1.50			2.25			0.22	0.72			7.46
7	60.74	29.39		1.68										8.41
8	59.18	29.12	25.54	1.42		0.08	2.08			0.21	0.68	3.75		7.17
9	59.18	28.99	25.44	1.41		0.05	2.09			0.28	0.72	3.49		7.40
10	58.86	29.47	25.59	1.67			2.19(*b*)			0.33	0.49	2.66	0.34	7.62
							2.29(*c*)							
							2.24(*d*)							
							2.26(*e*)							
							2.12(*f*)							
11							2.31(*d*)							
							2.04(*e*)							
							2.09(*g*)							
							2.24(*b*)							
							2.06(*c*)							
							2.18(*f*)							
Average	59.06	29.27	25.53	1.50	0.041	0.075	2.19	0.023	0.023	0.27	0.72	2.99	0.31	7.60
Tentative recommended value	59.10	29.15	25.55	1.45	0.04	0.08	2.05	0.025	0.023	0.20	0.72	3.20	0.27	7.25

* Separated iron by the use of H_2S in an ammoniacal tartrate solution; then determined it gravimetrically. See "The Analysis of Bauxite and of Refractories of High Alumina Content," by G. E. F. Lundell and J. I. Hoffman, Bur. Stand., *Jour. of Research*, July, 1928. (*a*) Reduced with zinc. (*b*) Combined oxides fused with pyrosulphate and reduced with H_2S. (*c*) Combined oxides fused with pyrosulphate and reduced with zinc. (*d*) Sample fused directly with pyrosulphate and reduced with H_2S. (*e*) Sample fused directly with pyrosulphate and reduced with zinc. (*f*) Combined oxides dissolved in HCl and reduced with $SnCl_2$. (*g*) Sample fused directly with pyrosulphate and titrated with titanous sulphate. (*h*) Result obtained by the use of the empirical factor 0.53. In addition to the constituents listed, two analysts have reported 0.06% of SO_3 and 0.004% of MnO. One analyst has reported 0.06% of BaO.

Summary of First Results for Flint Clay, No. 97

Constituent	Tentative recommended value	Extreme results	Average deviation from recommended value: All results	Average deviation from recommended value: All results within av. dev. of all results	Number of results outside of av. dev. of all results	Number of analysts: Reporting	Number of analysts: Reporting high results	Number of analysts: Reporting low results
SiO_2	42.85	42.09 –43.02	0.15	0.04	2	8	6	2
R_2O_3	42.60	42.35 –43.16	0.18	0.08	3	8	4	4
Al_2O_3	38.80	38.46 –39.48	0.24	0.10	5	8	3	5
TiO_2	2.35	2.28 – 2.63	0.14	0.07	3	8	6	2
ZrO_2	0.25	0.046– 0.26	0.08	0.02	1	3	1	2
P_2O_5	0.07	0.04 – 0.30	0.05	0.02	1	6	4	2
Fe_2O_3	0.98	0.95 – 1.66	0.18	0.06	8	9 analysts (17 results)	4 analysts (12 results)	4
V_2O_5	0.043	0.017– 0.045	0.010	0.003	1	3	1	2
Cr_2O_3	0.085	0.073– 0.091	0.008	0.006	1	3	2	1
CaO	0.10	0.06 – 0.33	0.08	0.02	3	8	4	3
MgO	0.26	0.21 – 0.38	0.04	0.02	4	8	3	4
K_2O	0.55	0.18 – 0.56	0.12	0.01	2	5	1	3
Na_2O	0.32	0.11 – 0.37	0.10	0.05	2	5	1	4
Loss on ignition	13.34	13.22 –13.96	0.16	0.04	3	8	5	3
	99.998							

Summary of First Results for Plastic Clay, No. 98

Constituent	Tentative recommended value	Extreme results	Average deviation from recommended value: Of all results	Average deviation from recommended value: Of all results within av. dev. of all results	Number of results outside av. dev. of all results	Number of analysts: Reporting	Number of analysts: Reporting high results	Number of analysts: Reporting low results
SiO_2	59.10	57.64 –60.74	0.42	0.13	2	10	4	6
R_2O_3	29.15	28.99 –29.75	0.19	0.07	4	10	5	4
Al_2O_3	25.55	25.27 –25.75	0.11	0.06	3	9	3	6
TiO_2	1.45	1.32 – 1.72	0.11	0.04	4	10	5	5
ZrO_2	0.04	0.032– 0.047	0.006	0.004	2	3	2	1
P_2O_5	0.08	0.05 – 0.091	0.013	0.007	2	5	2	2
Fe_2O_3	2.05	2.04 – 2.76	0.13	0.04	9	11 analysts (19 results)	15 results	4 results
V_2O_5	0.025	0.017– 0.030	0.005	0.004	1	3	1	2
Cr_2O_3	0.023	0.023– 0.025	0.001	0.001	0	2	1	1
CaO	0.20	0.17 – 0.45	0.08	0.04	3	9	7	1
MgO	0.72	0.49 – 0.91	0.08	0.03	3	9	3	4
K_2O	3.20	2.66 – 3.27	0.24	0.06	2	5	1	4
Na_2O	0.27	0.24 – 0.38	0.05	0.03	2	5	3	2
Loss on ignition	7.25	7.17 – 8.56	0.39	0.13	3	10	7	3
	99.958							

COMPARISON OF RESULTS REPORTED FOR THE TWO CLAYS

	Average deviation of results within the average deviation of all results	
	Flint clay no. 97	Plastic clay no. 98
SiO_2	0.04	0.13
R_2O_3	0.08	0.07
Al_2O_3	0.10	0.06
TiO_2	0.07	0.04
ZrO_2	0.02	0.004
P_2O_5	0.02	0.007
Fe_2O_3	0.06	0.04
V_2O_5	0.003	0.004
Cr_2O_3	0.006	0.001
CaO	0.02	0.04
MgO	0.02	0.03
K_2O	0.01	0.06
Na_2O	0.05	0.03
Loss on ignition	0.04	0.13

ANNUAL REPORT OF THE REFRACTORIES DIVISION RESEARCH COMMITTEE FOR 1929

During 1929 the Research Committee of the Refractories Division of the AMERICAN CERAMIC SOCIETY was organized to work along the following lines:

(1) Bringing to light problems which users of refractories encounter.
(2) Encouraging coöperation between workers who are conducting experiments or researches on refractory materials or processes.
(3) Endeavoring to prevent useless duplication of effort and to encourage checking of results of one investigator by another.
(4) Endeavoring to suggest subjects for experimentation and research in this field to those who request such information.

Because of the number of researches on refractories which are already financed and are being carried out, this Committee is acting in an advisory capacity and is not undertaking any research work itself.

The first work undertaken by this Committee has been to determine the general subject matter of researches needed by the refractories industries and by refractories consumers, and to obtain information as to who is conducting experiments and researches on refractories at present. Our present report deals with these two phases of the subject.

To carry on this work the Committee divided itself into three sub-committees. The reports of these sub-committees fit together so well that they are presented herewith without further comment. DONALD W. ROSS, *Chairman*

Report of Sub-Committee on Fireclay Refractories

The first duty of the Sub-Committee is to obtain some kind of a general view of research and experimental work now under way. Organizations in North America from which new information in this field may be expected are tabulated below. The table includes the name of the organization, the location of its laboratory, and the names of those persons who are most directly concerned with investigations on fireclay refractories.

The list is not claimed to be complete, but includes laboratories where the Committee has reason to believe that investigational work on fireclay refractories is now

going on. There are other laboratories with equipment and personnel suitable for such investigations, but they are not included here in the absence of definite information as to their work and programs.

Government Institutions	Location	Personnel
U. S. Bureau of Mines, Pittsburgh Experiment Station	Pittsburgh, Pa.	Nicholls, P. Sherman, R. A.[1] Rice, W. E.
National Bureau of Standards, Ceramic Experiment Station	Columbus, Ohio	Klinefelter, T. A. Rexford, E. P.
National Bureau of Standards, Division of Clay and Silicate Products	Washington, D. C.	Heindl, R. A.
Ontario Research Foundation	Toronto, Ont.	Westman, A. E. R.
Universities and Research Institutions		
Carnegie Institution of Washington, Geophysical Laboratory	Washington, D. C.	Greig, J. W.
Georgia School of Technology, Ceramic Dept.	Atlanta, Ga.	Henry, A. V.
Iowa State College, Dept. of Ceramic Engineering	Ames, Iowa	Cox, P. E. Moulton, D. A.
Massachusetts Institute of Technology, Dept. of Physics	Cambridge, Mass.	Norton, F. H.
Missouri School of Mines and Metallurgy	Rolla, Mo.	Holmes, M. E.
Ohio State Univ., Engineering Expt. Station, Clay Products Branch	Roseville, Ohio	Bole, G. A. Birch, R. E.
Ohio State Univ., Dept. of Ceramic Engineering	Columbus, Ohio	Watts, A. S. King, R. M.
Pennsylvania State College, Dept. of Ceramics	State College, Pa.	Shaw, J. B.
Rutgers University and the State University of New Jersey, Department of Ceramics	New Brunswick, N. J.	Brown, G. H.
Univ. of Illinois, Dept. of Ceramic Engineering	Urbana, Ill.	Parmelee, C. W. Hursh, R. K.
Univ. of North Dakota, Dept. of Ceramics and Ceramic Engineering	Grand Forks, N. D.	Budge, W. E.
Univ. of Saskatchewan, Dept. of Ceramic Engineering	Saskatoon, Sask.	Worcester, W. G.
Univ. of Washington, Dept. of Ceramic Engineering	Seattle, Wash.	Wilson, H.
West Virginia Univ.	Morgantown, W. Va.	Koehler, W. A.
Industrial Laboratories		
Babcock & Wilcox Co.	East Liverpool, Ohio	Richardson, R.
Carborundum Co.	Niagara Falls, N. Y.	Benner, R. C.
Findlay Clay Products Co.	Washington, Pa.	Ross, D. W.
General Refractories Co.	Baltimore, Md.	Heuer, R. P. Bell, M. L. Trostel, L. J.
Harbison-Walker Refractories Co.	Hays, Pa.	McDowell, J. S. Harvey, F. A. Pierce, R. H. H.

[1] R. A. Sherman joined the staff of the Battelle Memorial Institute, Columbus, Ohio, in March.

Harrop Ceramic Service Co.	Columbus, Ohio	Harrop, C. B.
H. Koppers Construction Co. (Mellon Inst.)	Pittsburgh, Pa.	Cole, S. S.
Laclede-Christy Clay Products Co.	St. Louis, Mo.	Hewitt, L. C. Crawford, J. L.
Mellon Institute for Industrial Research, Refractories Fellowship sponsored by American Refractories Institute	Pittsburgh, Pa.	McDowell, J. S. Ferguson, R. F. Cartwright, V. Daniel, G. W.
Orton Memorial Research Laboratory	Columbus, Ohio	Ellis Lovejoy
Vitrefrax Corporation	Los Angeles, Calif.	Curtis, T. S.

Technical Committees The following technical societies have committees interested in fireclay refractories:

AMERICAN CERAMIC SOCIETY, Refractories Division, Research Committee, D. W. Ross, *Chairman* (Findlay Clay Products Co., Washington, Pa.).

Joint Committee on Foundry Refractories sponsored by American Foundrymen's Assn. and AMERICAN CERAMIC SOCIETY, with ten other organizations coöperating. L. C. Hewitt, *Chairman* (Laclede-Christy Clay Products Co., St. Louis, Mo.).

American Refractories Institute, Advisory Committee on Research (see Mellon Institute above).

American Society of Mechanical Engineers, Committee on Boiler-Furnace Refractories, C. F. Hirshfeld, *Chairman* (Detroit Edison Co., Detroit, Mich.).

American Society for Testing Materials, Committee C8 on Refractories, G. A. Bole, *Chairman* (Ohio State University, Columbus, Ohio).

Boiler-Furnace Refractories One undertaking of a public character which has just completed a phase of its progress and which, therefore, may properly receive some special notice here, is the Committee on Boiler-Furnace Refractories, of the American Society of Mechanical Engineers. The work began in May, 1924, under the auspices of the U. S. Bureau of Mines, in coöperation with a group of companies operating central electric generating stations. In June, 1925, the coöperation was transferred from this group to the A.S.M.E. Committee. C. F. Hirshfeld, of the Detroit Edison Co., is Chairman of the Committee. It has expended about $30,000 during the past four years, and has held seven general meetings. The field results have been assembled in a bulletin of the Bureau of Mines which is in course of publication and have also been published from time to time by the SOCIETY in the form of eleven progress reports.

The following paragraphs give the personal impressions of one member of the Committee only, and must not be taken as an approved report from the Committee on Boiler-Furnace Refractories.

The work has grouped itself into three phases.

(1) A field study of the conditions of service met in nine combinations of fuel-burning equipment and fuels. Much has been learned from these studies about the practical factors in the failure of fireclay refractories, and data heretofore unavilable have been furnished as a basis for attack by the ceramic laboratory. Spalling and slag corrosion are the important processes, and the ash that must be considered is the ash that flies and sticks, not the ash left when a sample of the fuel is burned by the chemist. The two are not always the same.

(2) . A laboratory study to find the best type of experimental furnace in which to test the resistance to slag action of a given type of brick which is being considered for use with a given fuel. A furnace and method have been developed in the Department of Ceramic Engineering of the University of Illinois which gives a highly reliable though not absolutely certain indication of the probable service of the refractory. It tells as much as can be hoped for from any laboratory test which tries to speed up the processes that operate on a large scale. The speeding-up process inevitably introduces one or more new variables.

(3) A laboratory study of the reactions and equilibria that underlie failures. This phase, though it has made the least progress, offers the most promise. It consists of three parts: (*a*) a petrographic-microscopic study of the slagged refractories, both from the boiler-furnace and from the testing furnace. This did not yield much, because the rate of cooling of the specimens was uncontrolled. (*b*) A study of the 4-component and 5-component systems involved in the slagging of the refractory, the principal oxides concerned being silica, alumina, lime, ferrous oxide, and ferric oxide, with magnesia, soda, potash, sulphur, sulphur trioxide, and water as accessories. (*c*) A petrographic-microscopic study of the phases produced by refractory and slag at a constant temperature and in a controlled atmosphere, as preserved by quenching. This gives definite information on the reactions to be expected if the temperature and atmosphere in the boiler furnace are known.

It is clear that the chemical changes in the refractory during service are of two kinds: (1) changes in the surface portion, referable to temperature alone and (2) reactions between the adhering ash and this modified refractory surface. These reactions are profoundly influenced by the reducing or oxidizing character of the gases in contact with the surface. Simultaneous with these chemical changes occurs a physical change, the production of a stress which is the joint product of the reversible thermal expansion, the permanent volume change, and the thermal diffusivity of both the slag and the refractory.

As the matter now stands, if the engineer knows the boiler furnace from the combustion standpoint, and has samples of the coal ash and refractories, means are available whereby he can predict the corrosion of the refractory with fair certainty, and can make a much better guess than formerly as to its spalling. (R.B.S.)

Properties of Clays A line of work that promises well for the scientific basis of the ceramic industries is the work of several mineralogists, physicists, and geologists during the past few years on the constitution of clay minerals and the origin of clays. A symposium on clays was held by the Geological Society of America and the American Mineralogical Society at their Washington meeting in December, 1929. When these papers appear in the *Bulletin of the Geological Society*, the *American Mineralogist*, or the *Journal of the American Ceramic Society*, they will be well worth study.

Research Problems Several research problems have been suggested by members of the Sub-Committee and are listed below, accompanied in part by explanatory comments.

(1) The effect of gases on clays; (*a*) low temperature laboratory treatment, (*b*) service treatment.

Surprisingly little work has been done to determine what effect common furnace gases have on refractory clays. In the laboratory, samples of green and fired clays might be treated with such gases as SO_2, CO, CO_2, and partially burned hydrocarbons, in an effort to determine to what extent they were responsible for the destruction of brickwork. In connection with the laboratory work, data might be collected on results obtained in service. (V.C.)

(2) Effect of grain size on fired shapes; (*a*) density, (*b*) permeability, (*c*) apparent refractoriness, (*d*) spalling, etc.

The importance of grain size to manufacturers is apparent. With given raw materials there is a definite combination of grain sizes that will produce the most dense or porous body. Drying troubles may be reduced to some extent by use of proper size of grains. The permeability of a fired shape to gas is determined by the grain size as well as other factors. Where materials of different fusion points are combined a high apparent refractoriness may be produced. Information regarding this effect would be of particular interest where the life of a refractory is short. Strength re-

sistance to thermal shock, etc., would also be affected by changes in physical structure determined by grain size. (V.C.)

(3) Rate of absorption of heat by checker brick.

Data on the rate of absorption of heat by fired shapes would be of interest to users of recuperators and regenerators. A mathematical relation might be developed using specific heat, conductance, and an experimentally determined film constant. (V.C.)

(4) Cause of bulging.

Bulging has long been an objectionable feature connected with the manufacture and use of shapes. If a means of preventing it could be discovered much money could be saved. Elimination of entrapped air might reduce the effect. A colloidal study of the clay prior to drying might reveal useful information. Carefully controlled drying and firing might be of some benefit also. (V.C.)

(5) Relation of pyrometric cone equivalent to chemical analysis.

Although work has been done on correlating information on chemical analysis and P.C.E., no satisfactory relationship has been worked out. Evidently a greater knowledge of the chemical reactions of clay under fire is necessary. The chemistry of the crystalline compounds capable of identification by the petrographic microscope is fairly well known. An intensive study of the glass surrounding the crystals might yield the information necessary to tie P.C.E. to the alumina-silica equilibrium diagram. (V.C.)

(6) Purification of refractory clays.

Purification of refractory clays is of prime importance to most producers. Frequently trouble is experienced in finding a use for the impure clay that is mined with the good clay. If a commercial process of purification could be devised mining might be accomplished more cheaply. Water classifiers are in common use for cleaning coal. They might be adapted to the separation of clay from its impurities. Ore tables might also be arranged to do this work. Settling accompanied with flocculation, deflocculation, or a combination of the two presents another possibility.

(7) Spalling in suspended arches.

It is common experience that suspended arches made up of shapes of large cross-section are particularly subject to spalling. Possible causes of this spalling are (1) the stresses set up within the large block by thermal expansion and (2) stresses from without due to lack of space for expansion, either because of (*a*) design of arch or (*b*) filling in of spaces by dust or slag. Information is needed on (1) relative spalling of shapes of large and small cross-section, and (2) the stresses set up in arches by expansion, as determined by actual measurement. (R.A.S.)

(8) Spalling in oil-fired furnaces.

Brick in oil-fired furnaces are subject to serious spalling. It has been shown in one case at least that the extent and frequency of variations in temperature in an oil-fired furnace were not greater than in a powdered-coal furnace in which the thickness of the slag was similar. It was also shown that an alkali mineral was formed in the brick in the oil-fired furnace which was absent in those from the powdered-coal furnace.

This furnishes a lead toward a possible cause of spalling which should be further investigated to confirm or deny the indication. If confirmed, the problem would be extended in an attempt to find a type of brick in which this mineral was not formed or to find what might inhibit the formation of the mineral. (R.A.H.)

(9) Comparison of the effects on the properties of refractories when fired in laboratory kilns versus industrial kilns. (R.A.S.)
(10) Comparison of the deformation behavior of whole brick, under no load, at high temperatures, with P.C.E. value of the same brick. (R.A.H.)
(11) A determination of the rarer elements in fire clays. (R.A.H.)
(12) What is the cause of secondary expansion in brick prepared from certain types of fire clays? (R.A.H.)

In a survey of problems mention should be made of two fields of investigations that will always yield results: chemical analytical methods, and laboratory tests for quality. The importance of these was brought out in the discussion of the Committee's preliminary report at Toronto.

ROBERT B. SOSMAN, *Chairman*
VANCE CARTWRIGHT
R. A. HEINDL
R. A. SHERMAN

Report of Sub-Committee on Silica Refractories

The Sub-Committee on Silica Refractories of the Research Committee of the AMERICAN CERAMIC SOCIETY, begs to submit the following report regarding research problems which might be considered by our Committee.

In lining up these particular problems it is felt that (1) research to establish better conceptions of fundamental physical and chemical properties, (2) development of practical laboratory tests to determine variations in the properties which brick possess, and (3) service tests of brick in the presence of the complicated variety of factors which occur in many metallurgical and other heating operations, would cover the field which our Committee would be interested in. Experimentation, however, with different variations of raw materials, mixing, molding, drying, and firing conditions should be left to the private industrial laboratories which are directly interested, since this type of experimentation has its origin primarily in the desire for better plant efficiency, tonnage, etc., and is influenced by certain economical factors peculiar to the company or particular works involved. Problems of this latter type are so intimately associated with a company's private business that we have not considered them in furnishing the list of research problems below as follows:

(1) A study of the possibilities of developing cristobalite and tridymite as an interwoven aggregate of mechanically rigid crystals from rounded silica sand grains, similar to the structure obtained from crushed quartzite. This might open up vast supplies of a very accessible and cheap raw material.
(2) A determination of the cause of the more rapid inversion of Pennsylvania ganister as compared with the Baraboo ganister. An understanding of this phenomena might make it possible to effect economies in the firing of the western material.
(3) A systematic study of the mechanism of various bonding agents and mineralizers suggested from time to time. What effect do they have on the development of cristobalite and tridymite and on the usefulness of the brick under various standard service conditions? Iron oxide as a replacement for lime is of especial interest.
(4) A study of the development of cristobalite and tridymite from crushed ganister of the usual brick grind as a time-temperature consideration only (without the addition of fluxes). Lime ceases to be useful after the brick is fired. Could it be dispensed with entirely?
(5) A determination of the causes of staining or blotching of silica brick during firing. Some brick are rejected on color. The product seems otherwise good. If the color can be eliminated, such brick will find ready sale.
(6) The development of a practical spalling test for silica brick.
(7) A method of determining the resistance to abrasion at elevated temperature of silica brick. This is a particular problem in the use of silica brick in coke ovens.
(8) A careful petrographic study of the system SiO_2–FeO. This system has been partially studied by Greig, Herty, and others.
(9) The same for the system SiO_2–FeO–CaO. Some work exists on this system in the Russian literature. It should be made available in its entirety in the English literature.

(10) Determination of why very quartzy and sandy (clay?) brick do not spall as readily as the cristobalite-tridymite brick of very low quartz content made from crushed ganister.

L. J. TROSTEL, *Chairman*
R. A. HEINDL

Report of Sub-Committee on Magnesite and Chrome

Herewith is a list of research problems in connection with magnesite and chrome. Most of these are stated in such a general way that a single problem as listed would very easily provide material for a considerable number of studies.

Magnesite

(1) A study of the factors affecting the conversion of amorphous magnesia into periclase, including time-temperature relations, the action of catalytic agents, and the most effective concentration for the catalysts. Are the most effective catalysts (*a*) those which form solid solutions with magnesia, (*b*) those which form spinels or other crystalline compounds with magnesia, or (*c*) those which form glasses with magnesia and its impurities?

(1*a*) Same as the above, with special reference to the action of iron oxide.

(2) A study of the properties of magnesites differing in their content of iron oxide, silica, alumina, and lime, and calcined at a range of temperatures for varying lengths of time. Some of the most important properties are as follows:

(*a*) Specific gravity
(*b*) Constancy of volume at temperatures above that of calcination
(*c*) Sintering characteristics
(*d*) Thermal expansion characteristics; why is the thermal expansion of dead-burned magnesite higher than that of electrically fused magnesite?
(*e*) Thermal conductivity at furnace temperatures; can the high heat losses, attendant upon the use of magnesite brick as now made, be reduced?

(3) Petrographic study of affect of industrial slags upon magnesite brick and dead-burned magnesite.

(4) Development of a satisfactory spalling test for magnesite brick.

(5) Studies to increase strength of magnesite brick at high temperatures.

Chrome

(1) Petrographic study of various chromites, leading to a possible classification based upon their content of various minerals.

(2) Determination of physical properties of the various types of chromite.

(3) Petrographic study to determine effect of time and temperature of heating upon the essential and accessory minerals in chrome ores.

(4) Petrographic study to determine effect of industrial slags upon chrome brick and ores.

(5) Development of a satisfactory spalling test for chrome brick.

(6) Studies to increase strength of chrome brick at high temperatures.

J. SPOTTS MCDOWELL, *Chairman*
L. J. TROSTEL

The above report is respectfully submitted by the Research Committee, Refractories Divison.

DONALD W. ROSS, *Chairman*
ROBERT B. SOSMAN
VANCE CARTWRIGHT
R. A. HEINDL
R. A. SHERMAN
L. J. TROSTEL
J. SPOTTS MCDOWELL

FURTHER CHANGES IN AMENDMENTS TO THE REFRACTORIES DIVISION

Corrections are made in the amendments to the By-Laws of the Refractories Division. Under the section on "Rules," April *Bulletin*, p. 122, Donald W. Ross, Chairman of the Rules Committee reports the following corrections.

Line 17, following "nature" change "to" to "on."
Line 23, following "of the" omit "Executive committee signed by the."
Line 18, following "information," change remainder of paragraph to read "The chairman of the research committee shall be the division's representative on the research committee of the parent SOCIETY, being the representative provided for under (6) (*b*)."

MINUTES OF THE STANDARDIZATION COMMITTEE ON FELDSPAR[1]

Present Committee Members: B. C. Burgess, *Chairman*, James Hamilton, V. V. Kelsey, T. C. Earnill, F. C. Flint, Edward Schramm, A. S. Watts, H. G. Wolfram, L. Navias for L. E. Barringer, General Electric Co., Henry N. Hanna for J. P. Rodgers, Seaboard Feldspar Co., A. N. Finn for P. H. Bates, Bureau of Standards, and Harry H. Steidle, Bureau of Standards.

Absent: Chas. E. Golding.

Visitors: W. J. Parker, Feldspar Grinders' Institute, F. P. Knight, Jr., Oxford Mining & Milling Co., C. W. Parmelee, Univ. of Illinois, and G. W. Wray, Bureau of Standards.

The meeting was opened at 5:20 P.M. by the Chairman with a brief word of progress to date.

The Committee approved a recommendation by L. Navias that fineness determinations be made on the percentages remaining on the No. 325-sieve for product No. 140 and finer, with the understanding that these be added to Table I at the next revision.

A. S. Watts emphasized the fact that the standards under consideration should be looked upon as classifications rather than definite specifications.

F. C. Flint, Chairman of the Sub-Committee on Feldspar for the Glass Industry, agreed to furnish a proposed method of determining silica content.

He further reported the recommendations of the Glass Sub-Committee for Feldspar as follows:

The basis to be the percentages of silica, alumina, and iron is designated numerically as follows: $69 - 17 - x$, which will indicate a feldspar having 68 to 69.99% silica, 17 to 17.99% alumina, and a maximum of 0.15% iron.

Additional silica and alumina classifications are to be used though the range of commercial feldspars contain 2% silica, 1% alumina and 3 iron divisions, namely *x* containing a maximum of 0.15% iron, *xx* containing a maximum of 0.20% iron, and *xxx* containing more than 0.20% iron.

It was decided that the method of chemical analysis recommended by the Sub-Committee on Glass be referred to the chemistry division of the Bureau of Standards with the request that they use it as a basis of a recommended standard method of analysis, adding such paragraphs as are necessary for the determination of silica, alumina, iron, calcium, magnesium, potash, soda, and loss on ignition.

In the classification of body grades the only change from that proposed is in the numbering of the groups. The odd numbers are used to correspond to the percentages in the middle of the group, for example, No. 67 to include silica content from 66 to 67.99%.

No changes were made in the classification of glaze feldspars.

The proposed method of making screen tests was approved. An alternate method of screen testing was suggested by E. Schramm as follows:

A 250-g. portion is weighed out, stirred into a slip, and washed through the coarsest screen with the aid of running water. The material passing the screen is collected in a bowl or other container, stirred into a slip, and washed through the finest screen with copious use of running water. The residues are dried on the screens and weighed.

NOTE: Several minor editorial changes were made in numbering the various classes which make no difference in the classification but provide consistency throughout.

It was voted that the effective date for the production of feldspars under the commercial standard classifications should be fixed at three months after the date announcing the success of the project.

The date for revision of the classifications was fixed at one year from the date on which they become effective and annually thereafter.

[1] Royal York Hotel, Toronto, Canada, February 18, 1930.

The Standardization Committee which represents all interests of the feldspar industry was continued as the standing committee which will review comments regarding the classifications and consider their revision when necessary.

The meeting adjourned at 8:15 P.M.

Respectfully submitted,
H. H. STEIDLE, *Secretary*

LOCAL SECTION NEWS

Pittsburgh Section[1]

A meeting of the Pittsburgh Section of the AMERICAN CERAMIC SOCIETY was held on Tuesday evening, April 8.

An interesting paper entitled, "High Voltage Insulators," was given by Hobart M. Kraner of the Westinghouse Electric and Manufacturing Company.

The following members attended: Robert F. Ferguson, Earl C. Petrie, Drury D. Turner, C. E. Parmelee, Jack H. Waggoner, F. W. Preston, L. R. Meyer, P. D. Helser, H. E. White, H. M. Kraner, Fred Sauereisen, G. T. Stowe, F. L. Jones, J. R. Crandall, George A. Wills, George E. Crawford, W. Keith McAfee, L. R. Kirk, O. M. Jenhansen, E. W. Scripture, Jr., and Robert C. Boyd.

The next meeting will be held on Tuesday, May 13, at which time a paper on the manufacture of refractories will be presented by J. S. McDowell. The paper will be illustrated with moving pictures.

Baltimore-Washington Section[2]

The Baltimore-Washington Section of the AMERICAN CERAMIC SOCIETY held the usual dinner meeting at the Emerson Hotel in Baltimore, Saturday, March 1, 1930.

T. S. Curtis, Vice-President in Charge of Research, Vitrefrax Corporation, Los Angeles, Calif., was the speaker. His subject was "The Growth of Mullite in Ceramic Bodies," and was illustrated with moving pictures. His talk was very well received, and aroused an unusual amount of comment, especially concerning the apparatus used in the experimental work presented.

Officers for the year 1930–1931 were elected and are as follows:

Chairman: W. N. Harrison, Bureau of Standards, Washington, D. C.
Vice-Chairman: E. Greenstreet, Baltimore Enamel & Novelty Co., Mt. Winans, Md.
Secy.-Treas.: E. G. Porst, Porcelain Enamel & Mfg. Co., Eastern & Pemco Aves., Baltimore, Md.
Councilor: R. A. Heindl, Bureau of Standards, Washington, D. C.

W. N. Harrison announced the appointment of L. J. Trostel, General Refractories Co., Baltimore, Md., to the position of Chairman of the Program Committee.

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[1] R. C. Boyd, *Secretary.*
[2] Lewis E. Mong, *Secretary-Treasurer.*

NOTES AND NEWS

NEWS FROM THE CERAMIC SCHOOLS

New York State Legislature Passes Bill for New Ceramic Building at Alfred

Notice has been received from Alfred, N. Y., announcing the appropriation of $175,000 for a new ceramic building for the New York State School of Clayworking and Ceramics. The bill was signed by Governor Roosevelt on April 7, 1930. The bill had been passed by both houses of the Legislature and was then placed in the hands of Governor Roosevelt for signature or veto.

Dr. Binns and President Davis secured an interview with the Governor before he signed the bill and Senator Knight, Assemblyman Goodrich, and Com. Graves, the latter of the Education Department, worked hard to secure the Governor's signature for this bill. A similar bill was presented to Governor Smith, who vetoed it.

The new ceramic building is to be erected as soon as possible.

Ohio State University[1]

Meeting of Student Branch

The Student Branch of the AMERICAN CERAMIC SOCIETY held its regular business meeting on Thursday, March 6, at the new Orton Laboratory in Columbus, Ohio. The talk of the evening was given by General Edward Orton, Jr., President of the AMERICAN CERAMIC SOCIETY and the owner of the Standard Pyrometric Cone Co. He started the first ceramic engineering department in the world at Ohio State University in 1895. His subject was a general history of the manufacturing of the standard pyrometric cone. After the talk the members were conducted through the laboratory, and the various steps in the manufacture of the cones were pointed out and demonstrated. The laboratory has been open only since January 1 and is modern and well planned. It has one of the best testing furnaces in the country.

News of Ceramic Graduates

John Musselman, 1929, has resigned his position with the Standard Sanitary Mfg. Co. of Tiffin, Ohio, and has accepted a position in the refractory division of the Pittsburgh Plate Glass Co. at Creighton, Pa.

John H. Grady, 1927, has resigned his position with the Claycraft Brick Co. of Columbus, Ohio, and has accepted a position in the glaze department of the National Fire Proofing Co. at Canton, Ohio.

George M. Grady, 1925, has resigned his position with the Northwestern Terra Cotta Co. of Chicago, Ill., and has accepted a position with the Owen China Co. at Minerva, Ohio.

Paul G. Larkin, 1915, has resigned his position with the Gladding, McBean & Co. of Lincoln, Calif., and has accepted a position with the Washington Brick, Lime, and Sewerpipe Co. at Spokane, Wash.

More than 60 graduates of the Ceramic Engineering Department of Ohio State University were in attendance at the Annual Meeting of the AMERICAN CERAMIC SOCIETY at Toronto, Canada, in February, and a reunion banquet was held at which some interesting and valuable data were accumulated by questionnaire.

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[1] Glenn A. Hutt, *Corresponding Secretary.*

Student Activities Alfred Ault, Gilbert Soler, Karl Schwartzwalder, and Glenn Hutt represented the Student Branch of the AMERICAN CERAMIC SOCIETY at the Annual Meeting at Toronto, Canada.

Keramos, honorary ceramic engineering fraternity, initiated G. A. Bole, professor in ceramic engineering at Ohio State University, and Geo. H. Brown, professor of ceramic engineering at Rutgers University at the Annual Meeting of the AMERICAN CERAMIC SOCIETY in Toronto. The initiation was conducted by members from the Ohio State and Illinois chapters of Keramos. Several of the old members attended the ceremonies.

Sigma Gamma Epsilon elected the following seniors: Charles Gerster, George Tuttle, N. G. Wedemeyer, Stephen Spires, and Glenn Hutt. This fraternity chooses its members from the geology, mining, metallurgy, and ceramic fields. Harry Thiemecke, senior ceramic, was chosen last year to membership.

UNIVERSITY OF ILLINOIS DEDICATES NEW LABORATORY

The University of Illinois is planning to dedicate the new Materials Testing Laboratory, to celebrate twenty-five years of research of the Engineering Experiment Station, and to have a conference on teaching and research in engineering materials, on May 2 and 3, 1930. The dedication will occur on Friday morning, while the celebration of twenty-five years of the Engineering Experiment Station will consist of a program Friday afternoon and a banquet Friday evening. An invitation is extended to the members of the AMERICAN CERAMIC SOCIETY to attend these exercises.

DESIGN COPYRIGHT BILL[1]

A bill of the utmost importance to American designers, and hence to the development of American industrial art, is now pending before Congress. This is a bill introduced into Congress by Mr. Vestal last December, known as H. R. 7243, the purpose of which is to substitute copyright for original designs in place of the present patent registration. The intention of the law now in existence is not altered, but a quicker, cheaper, and more practical method is substituted for a method which has, with the passing of time, become clumsy and almost useless.

By extending the copyright privilege to designers our Government would be simply employing a method long in vogue by the most enlightened nations of Europe.

If an author can copyright a book, an article, a drawing, a painting, or even a piece of music, why should not a designer be able to copyright a design? Obviously he should, but as the law now stands it is impossible. A design must be registered at the Patent Office, and, before the required process is accomplished, the season is almost if not entirely over; and if the design is effective may have been copied again and again.

[1] *American Magazine of Art*, April, 1930.

The pirating in this country of designs by manufacturers and their employees has become in recent years a national disgrace. At a hearing before the Patent Committee of the House of Representative, held in the House Office Building on February 13 and 14, Horace Cheney, of Cheney Brothers, and others gave surprising testimony of the extent to which this iniquitous practice is carried.

Mention has already been made in this magazine of the difficulty experienced by representatives of The American Federation of Arts in securing loans of industrial art objects in France last summer, because of the extent to which original designs of ceramics lent by French manufacturers the previous year had been copied in this country.

There is no American who can have failed to feel pride heretofore in the fact that universally abroad Americans are trusted by foreign merchants, and there is certainly none who will not desire this national reputation for honesty to be preserved. There is really no difference between stealing the original product of a creative mind and the gold which is the reward, unless perhaps the former is the more iniquitous.

The only opposition to the Vestal Design Copyright Bill as presented at the hearing was from various retail merchants' associations who claimed that if designs were copyrighted competition would be limited and selling checked, the latter through fear of infringement procedure. But the bill specifically provides that there shall be no recovery against an innocent infringer, and that exposure for sale of infringing goods by any other than the manufacturer shall be unlawful only when purchased after actual knowledge that the design is copyrighted.

There was considerable quibbling as to the exact meaning of the word "original." But no copyright law could exist if there were not common agreement in regard thereto.

The American Federation of Arts was represented at this hearing by the Secretary, who, on request, spoke briefly in favor of the bill at the close of the hearing, after the opposition had been heard.

At the recent meeting of the Board of Directors of the American Federation of Arts approval was unanimously given to the purposes of the bill, and the Secretary was authorized to bring it to the attention of the Federation's chapters in order that there might be a widespread expression of opinion on the part of those who are chiefly concerned, in regard to the much-desired legislation.

The United States is today a great manufacturing country, leading in quantitative production. With our designers properly protected and the pirating of designs put to an end, there is every reason why we should become also foremost in qualitative production as well. This would, in large part, be the ultimate result of the passage of this bill.

Write to your Senators and Representatives in Washington at once.

ANDALUSITE MINERALS IMPORTANT IN MAKING OF SPARK PLUGS AND REFRACTORIES[1]

Andalusite, a little-known mineral which plays an important part in the making of the spark plug, vital in the automotive and aviation industries, comes mainly from the high altitudes of the Inyo Mountains of California, where it is transported in sacks by burros down a steep trail four and one-half miles long to the valley 6000 feet below.

The minerals andalusite, cyanite, and sillimanite differ in physical properties but have the same chemical composition. Although all three of these silicates of alumina are employed in industry they are often referred to indiscriminately as "sillimanite." Another mineral that is closely related to this group is dumortierite.

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[1] Received from the U. S. Bureau of Mines, Department of Commerce, Washington, D. C.

Prehistoric implements made of compact sillimanite are found in western Europe and have a certain resemblance to jade implements, but the mineral was named in honor of Benjamin Silliman, the elder, who was born in 1779. (Alice V. Petar, report published by the Bureau of Mines.)

The commercial utilization of this group of aluminum silicate minerals is a recent development. It had its beginnings during the World War in the search for a suitable insulating material for spark plugs. The synthetic porcelain insulators available at that time did not meet the demands placed upon them in war-time service in airplane engines. In the course of tests at the Bureau of Standards some years ago on spark-plug porcelains, it was determined that in a good spark-plug porcelain the quartz should be eliminated from the composition and replaced by some other substance. Artificial sillimanite was used in the manufacture of porcelain but was found to be impractical commercially. Natural sillimanite, found in the Inyo Mountains in California, was then developed for this purpose.

Although it is in the manufacture of spark plugs that the andalusite minerals have been most widely used, these materials have various other industrial uses. They are employed in the production of laboratory ware, including crucibles, casseroles, evaporating dishes, and other heat-resisting articles. Mullite refractories are used in the glass industry. Recent tests indicate that in firing electrical porcelain, saggers containing cyanite have a much longer life than those made from ordinary mixtures. Cyanite has likewise been used, more or less experimentally, in spark plugs, for refractory brick, in electrical porcelain and chinaware, and in glass and enamelware.

Cyanite produced from a very large deposit in Imperial County, Calif., is used in the manufacture of various ceramic materials for the porcelain, white ware, and electrical insulator trade and including super-refractories in the form of prepared grains, cements, and finished raw materials, together with a line of refractory brick and shapes for the glass industry.

Dumortierite is used with andalusite in the manufacture of porcelain for spark plugs. The only commercial deposit now known is in Pershing County, Nev.

Mullite refractories may be made by fusing alumina and silica in an electric furnace, but at present they are made principally from the natural aluminum silicates.

The three minerals cyanite, andalusite, and sillimanite are converted by heat to mullite and silica or to mullite and a siliceous liquid, but they are not interchangeable. The lowest temperature at which the alteration takes place is different for each mineral. Cyanite alters at the lowest temperature, sillimanite at the highest. In none, however, does the change take place sharply at any definite temperature, but progresses slowly over a considerable range.

Dumortierite can be converted to mullite below 1250°C, and hence it too can be incorporated into white ware without precalcination.

Mullite refractories may be manufactured either in the electric furnace or in gas- or oil-fired kilns.

In California and Nevada, where andalusite and dumortierite, respectively, are produced, the material is mined selectively and hand sorted. Both properties being situated some distance from a railroad, the selection of material is made carefully. At the mine the large rocks are broken by hand into small pieces and placed in sacks at once, the sacks protecting the mineral from contamination during storage. The selection of the material is based upon frequent specific gravity tests.

In the United States the commercial production of these aluminum silicate minerals apparently commenced in 1920 and has progressed more or less steadily since that year. Practically no statistics are available, however, for production in this country.

In California from 1922 to 1926, inclusive, the total production of the sillimanite group of minerals amounted to 9394 tons, valued at $301,790.

In Nevada figures of production are not available, since there is only one producer, which, however, has operated its dumortierite property fairly steadily since commencing operations in the latter part of 1925.

In Virginia one producer at Charlotte Court House has operated intermittently.

In North Carolina a few tons have been mined from time to time, chiefly for experimental purposes.

In the United States many scattered occurrences of sillimanite have been reported, but no production of consequence has been made. The Inyo Mountain products are marketed under the trade name "sillimanite," but the principal ingredients are andalusite and dumortierite.

The largest known deposits of natural sillimanite are in India, in Assam, in the neighborhood of Sona Pahar, north of the village of Nongmaweit, in Nongstoin State, and in Rewa State, Central India, near Pipra. At the former deposit, which is on the Khasi Hills Plateau, it has been estimated that there is a total quantity of 83,000 tons available, including float ore.

The largest known deposit of andalusite is that in the White Mountains of the Inyo Range, in Mono County, Calif. It is located at an elevation of 10,000 feet on the southwestern slope of White Mountain and is said to contain very large reserves.

Occurrences of andalusite have also been noted in South Dakota, where it is found in the central Black Hills in a belt of pegmatitic masses extending from near Oreville northeastward to Summit Peak. During 1925, trial lots amounting to about 16 tons, valued at $635, were shipped by three producers.

Cyanite occurs in varying quantities in Arizona, California, Georgia, Massachusetts, New Mexico, North Carolina, Pennsylvania, Virginia, and Wyoming. The largest production has been from California, but substantial quantities appear to be available in North Carolina, Virginia, and other states.

Dumortierite has been reported in Arizona, California, Colorado, Nevada, New Mexico, New York, and Washington, but the only deposit of commercial importance appears to be in Nevada. There are four occurrences of dumortierite in Nevada. The largest of these is in Humboldt Queen Canyon, 6 miles east of Oreana, Pershing County.

Indian sillimanite has been on the American market since about 1923 and is said to be of good quality. Imports of sillimanite, however, are not listed separately, and no reliable estimates are available as to the quantity received from India or other countries. Small shipments of American cyanite appear to have been made from time to time to Europe, but chiefly for experimental purposes, and no regular trade has yet developed.

The demand for the four minerals has not been extensive. The largest consumers have their own deposits which have apparently been of sufficient size to satisfy their needs. There is reason, however, to believe that a producer who could guarantee an assured tonnage of cyanite, reasonably free from mica, garnet, and similarly undesirable impurities, would be able to secure orders promptly for 10,000 to 15,000 tons and perhaps considerably more annually. Since much of this business would have to be taken in competition with other refractory raw materials, the price would doubtless be determined on the basis of actual performance. The foregoing estimated tonnage is based on an assumed price of $15 to $20 delivered at Pennsylvania plants.

Further details are given in Information Circular, No. 6255, "Sillimanite, Cyanite, Andalusite, and Dumortierite," copies of which may be obtained from the United States Bureau of Mines, Department of Commerce, Washington, D. C.

SOCIETY OF GLASS TECHNOLOGY

A general meeting of the Society of Glass Technology was held in Sheffield, on February 19, 1930. Three papers were presented.

(*a*) "The ternary system K_2O–CaO–SiO_2," by G. W. Morey, F. C. Kracek, and N. L. Bowen. (A communication from the Geophysical Laboratory, Washington. D. C.)

This study of phase equilibrium relations in the system K_2O–CaO–SiO_2 is one of a series of papers dealing with various combinations of rock-forming ingredients, in each of which one or more of the alkali oxides is present. The compositions studied give in detail the melting relations in that portion of the ternary system from potassium metasilicate, $K_2O{\cdot}SiO_2$, to potassium calcium orthosilicate, $K_2O{\cdot}CaO{\cdot}SiO_2$, to wollastonite, $CaO{\cdot}SiO_2$ and all more siliceous mixtures. Less siliceous mixtures are difficult to study because of the volatility of K_2O, of the highly hygroscopic nature of mixtures rich in K_2O, and of the difficulty of freeing these preparations of CO_2, or because of the high temperatures involved, but data are given for a few compositions outside of the above limits. The density and optical properties of the glasses composed of these 3 oxides throughout the range within which it is possible to form glasses in the laboratory have been determined and will be published later. The entire program is preliminary to the addition of water to these same systems, and the study of the equilibrium relations in the systems so obtained at high pressure and temperature, with a view to the application of the knowledge so obtained to the elucidation of geologic and technical problems.

(*b*) "Note on the determination of boric oxide in glass," by Violet Dimbleby. (Department of Glass Technology, The University, Sheffield.)

The difficulties attendant upon the determination of boric oxide in glass are enumerated. The method of E. T. Wherry and the modified procedure suggested by E. C. Sullivan and W. C. Taylor, previously investigated some years ago in the Department of Glass Technology, at Sheffield, by J. D. Cauwood and T. E. Wilson, (see *Jour. Soc. Glass Tech.*, **2**, 246 (1918)) have yielded satisfactory results in the Department. These methods have been applied frequently to glasses differing widely in composition.

Independent workers, however, employing these methods, particularly that of Wherry, applied to the determination of small quantities of boric oxide in simple glasses, have found some difficulties. Accordingly, the method was well discussed with several analysts, and a further series of tests was undertaken at Sheffield, to discover the points at which errors could creep into the work, and the likely magnitude of such errors.

Particulars of these tests and the results obtained are given, and the procedure previously outlined for the determination is modified and amplified. It is shown that in order to arrive at accurate results, the amount of calcium carbonate used for precipitation and the time of boiling must be carefully regulated. This precipitate should be dissolved in hydrochloric acid and reprecipitated.

Close agreement was obtained in results by an independent analyst, and two workers at Sheffield, when determining the low boric oxide content of a simple commercial glass, the procedure being such as to include the precautions mentioned above.

(*c*) "The thermal expansion of glasses of three or more constituents," by W. E. S. Turner and F. Winks.

An examination of the thermal expansion of glasses of various types shows that the expansion curves conform to one of four types, namely, glasses whose expansion curves showed 4, 3, 2, or 1 change point, over the temperature interval 0° to the critical temperature of the glasses.

In glasses of the type $6SiO_2$, $(2\text{-}x)$ Na_2O x RO, or R_2O_3, four change points occur at temperatures of 130, 250, 350°, and the critical temperature. As the parent soda-silica glass ($6SiO_2{\cdot}2Na_2O$) also shows a similar type of curve, it is considered that the soda-silica compounds are the dominant factors in the glasses containing them. The addition of a second basic oxide does, however, have a tendency to suppress the 350° change point.

By plotting the expansion coefficient for each temperature interval against % composition for glasses containing barium, lead, zinc, and iron oxide, a series of straight-line curves is obtained. It is thus possible to obtain factors for these oxides which can be used for the calculation of the expansion of glasses from 0° to the critical temperature.

The types of glass showing three and two breaks in the expansion curves are given and briefly discussed. A more detailed examination is given of the glasses showing

straight-line relationship from 0° to the critical temperature, and while the curves of the boric oxide silica glasses of this group can be explained by the nonexistence of compound formation, such a condition is difficult to accept in regard to soda-silica glasses and potash lead oxide glasses, which give similar types of curves.

In regard to the potash lead oxide silica glass of the "full crystal" composition, there is evidence that glasses composed of lead oxide and silica only, will show no change points over the temperature region 0 to *Ct*. This is borne out by a consideration of the lead oxide factor for soda lead oxide glasses.

The rapid expansion of glasses, over the critical zone (namely *Ct* to the upper annealing temperature) was shown to be influenced by various oxides in glass. The oxides of iron and boron are particularly effective in this connection in imparting a pronounced increase in the expansion of glasses over this range. To a less extent alumina, in certain types of glass, act similarly.

The effect of strain and heat treatment on glasses are also dealt with.

Strained specimens of certain boric oxide glasses show a negative expansion in the higher temperature zones. A decrease in expansion of strained lime soda glasses is also realized, but not to such an extent as in the boric oxide glasses. In some of the latter glasses, a decrease in the expansion is realized, some 270° below the upper annealing temperature and the necessity of slow cooling to this temperature for the realization of strain-free glass is stressed.

The last two papers were accepted but not read.

(*d*) "Notes on various old glasshouses," by Francis Buckley.

(*e*) "A study of the chemical reactions in the melting of potassium-borosilicate glass," by M. A. Besborodov and Z. M. Silberfarb.

JOSIAH WEDGWOOD BICENTENARY[1]

By Sir Francis Joseph, C.B.E.

As the weeks pass, an ever-widening circle of interest is created in the forthcoming Bicentenary Celebrations of Josiah Wedgwood. Amid the excitement of preparations and the rivalry which has been created in arranging for various episodes of the great Pageant to be performed by different organizations, it is well that we should keep in mind the aim behind all our activities.

History is a great guide to mankind. It is invaluable as a teacher. It is a signpost to direct the oncoming generation along the highway of time and to guide the progress of the race. The figures which stand out in history are always fascinating. This is inevitable. They are the men and women who have had qualities which have removed them from the commonplace. If those qualities were beneficient in aim and benevolent in intention, so much the better, but all historical personages command our attention.

When we think of North Staffordshire and the proud preëminence it now enjoys in all the manifold expressions which the word "pottery" suggests, we consciously or unconsciously pay homage to the great pioneers who, by their industry, artistic conception, research, and sound workmanship, laid sure foundations in the years that have gone.

Josiah Wedgwood, born in 1730, will for all time be considered the outstanding figure in the pottery industry. Not that other men were not equally inventive, but that in old Josiah there was a touch of that illusive but fascinating quality we term genius. When we remember his humble beginnings and recall his handicaps of ill-health, weak constitution, and lack of education, a tribute to his memory and past achievements is all the more deserved. There is a notable company of men who have made very definite contributions to the development of the pottery industry, though they were overshadowed by Josiah Wedgwood. Whieldon, Spode, and others deserve our lasting gratitude.

It is because the world has given to Josiah Wedgwood a niche in the temple of fame as England's master potter that we have determined to celebrate in a worthy manner the Bicentenary of his birth. How can this best be done?

The finest tribute we can pay to the memory of this great man is to resolve that the standard of craftsmanship, honest value and beauty of design, which distinguished all his productions, shall remain the guiding principle of the industry.

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[1] *Evening Sentinel*, Stoke-on-Trent.

The high quality of the goods made by the British workers won for Great Britain an enviable supremacy in the markets of the world. In recent years, other countries have learned a good deal and we can no longer consider our position unassailed.

I have unbounded faith in the future. As the standard of life is improved, both in the Dominions and in foreign countries, there must be an increasing demand for pottery, and in this expansion we must share, providing we hold fast to those principles which have up to now placed us in the forefront.

The celebrations will last for a full week. On Sunday, May 18th, the Lord Mayor and City Council, accompanied by the most representative gathering which has ever assembled in the city, will attend a service in Stoke Parish Church. One of the outstanding figures of the Church, the Lord Bishop of Winchester at the special request of the Lord Bishop of Lichfield, has kindly consented to be with us.

As we raise our songs of praise and thanksgiving in the Parish Church, there will come to our minds the thought that in the churchyard lie the remains of old Josiah, while in another part of God's acre rest the remains of Josiah Spode and others who lived in his age. Linking us to present times, our eyes will rest upon the memorial to Cecil Wedgwood, who gave his life in the Great War, and who was the first Mayor of the Federated Borough of Stoke-on-Trent.

It is a matter of great gratification that the Free Church and the Roman Catholic Church will link themselves to the religious celebrations, so that the ideals of citizenship will be the dominant note at all services throughout the district.

On Monday, Her Royal Highness Princess Mary, Countess of Harewood has graciously consented to visit the city. She will be welcomed at the Town Hall, first, by the Lord Lieutenant of the county, and then introduced by him to the Lord Mayor. At 11 A.M. Her Royal Highness will perform the opening ceremony of the great Exhibition of Modern Pottery which will be held in the King's Hall.

This Exhibition will be the finest which the world has seen; that is a great claim, but every visitor will feel that it is justified when he has passed through the King's Hall that week. We must see that our friends from far and near visit this wonderful display. It will demonstrate that the generations which have passed through the art schools of the city have absorbed a love of their craft and a capacity, both in design and workmanship, which have made them worthy successors of a great past.

At the Hanley Museum, Mr. Maxwell, the Curator, will display—in a newly-decorated interior—a most interesting collection of articles which will enable the visitor to form a very good idea of the life, times, and work of Josiah Wedgwood. Her Majesty, the Queen, has honored the city by consenting to be Patron of this Exhibition. Her Royal Highness Princess Mary will formally open it at noon.

Old Josiah was a man full of ideas. Not only did he win for himself an outstanding position in the industrial world, but he placed us under an eternal obligation to him by being the pioneer for the making of the Trent and Mersey Canal and for the improvement of our roads.

Tuesday, therefore, will be known as Transport Day, when we shall welcome representatives of every branch of transport. It is fascinating to think that Lady Bailey, representing aviation, will fly down from London to Stoke-on-Trent on that day in about two hours whereas two centuries ago the time taken to travel that distance would have been from four to five days. A direct descendant of Josiah Wedgwood will be present in the person of Sir Ralph Wedgwood, now General Manager of the London and North-Eastern Railway Co. He, Sir Josiah Stamp, and the Railway Queen will represent the railways. There will also be representatives of every other branch of transport, shipping, canals, roads, etc.

Wednesday will be made notable by a visit from the members of the Ceramic Society. From all countries where the pottery industry exists will come delegates to pay a tribute to the memory of Josiah and to join with us in our festivities. On the afternoon of that day the Lord Lieutenant of the County, the Earl of Harrowby, and the Countess of Harrowby will entertain our distinguished visitors at Sandon Hall, one of the stately homes of England. A distinctive note will be struck on that occasion, when a Freeman of the city, The Right Hon. S. M. Bruce, now on a visit to this country, will be the speaker at the luncheon on that day.

It is fitting that we should link the sons of Stoke who have won distinction in the world to our effort. Sir Oliver Lodge, a native of Stoke and an honored Freeman of our city, will voice our welcome to our guests on Thursday, which will be known as Industrial Day. Then the representatives of all the great bodies, both employers and employed, will be with us.

One of the most impressive gatherings will be on Friday, which is termed Overseas

Day. All the High Commissioners of our great Dominions and their ladies, together with Ambassadors, Ministers, and Trade Commissioners of foreign countries to which we export large quantities of our goods, will honor us with their presence.

Saturday is Staffordshire Day, when the Mayors of Staffordshire and the Chairmen of all the Staffordshire local authorities will be present. There will be more gold chains in the city of Stoke-on-Trent on that day than have ever been seen in any provincial city. The Staffordshire Society of London will make a pilgrimage to Stoke on that day to join us in our festivities and to renew old friendships.

The most spectacular event of our celebrations will be the great Pageant, in which 5000 people will take part. This Pageant will be different from any other which has been held in the country.

It will be a living representation of the history of pottery, stretching from the days of the Roman occupation right down through the ages until it visualizes the achievements of the 20th Century.

I look for very big attendances day by day, and suggest that those who wish to see it should take advantage of the opportunity which now presents itself of booking their seats at the Pageant Office in the Town Hall.

Every evening, on the Pageant Ground, there will be a Military Tattoo. The personnel for the Tattoo will be drawn from the various units of our Territorial Forces. We are greatly indebted to Colonel Harry Clive, O.B.E., T.D., the officers commanding the various units, and to all concerned, for the splendid way in which they have associated themselves with our week.

In addition, on each evening, interesting displays will be given by the Scouts, Guides, and other organizations.

This is an outline of our great week. All that remains now is that we shall, without exception, devote ourselves to broadcasting, both locally and to the world, the greatness of the occasion, and so link ourselves to the effort that we shall prove that we value the labor of those who have gone before and place on record that Stoke-on-Trent is the home of the great pottery industry, the prosperity of which means so much to us all.

CALENDAR OF CONVENTIONS

Organization	Date	Place
American Assn. for the Advancement of Science	December 29, 1930–January 3, 1931	Cleveland, Ohio
AMERICAN CERAMIC SOCIETY	February 22–27, 1931	Cleveland, Ohio
Pittsburgh Section	May 13, 1930	Pittsburgh, Pa.
American Concrete Institute	February, 1931	Milwaukee, Wis.
American Electrochemical Society	May 29–31	St. Louis, Mo.
	September 25–27, 1930	Detroit, Mich.
American Foundrymen's Assn.	May 12–16, 1930	Cleveland, Ohio
American Gas Assn.	October 13–17, 1930	Atlantic City, N. J.
American Institute of Chemical Engineers	June 4–6, 1930	Detroit, Mich.
American Mining Congress		
Annual Convention of Practical Coal Operating Men and National Exposition of Coal Mine Equipment	May 5–9, 1930	Cincinnati, Ohio
Western Division Meeting	October 13–18, 1930	El Paso, Texas
Annual Convention	December 1–6, 1930	Washington, D. C.
American Refractories Institute	May 19–20, 1930	White Sulphur Springs, W. Va.
American Society of Mechanical Engineers		
Semi-Annual Meeting	June 9–12, 1930	Detroit, Mich.
American Society for Steel Treating	September 22–27, 1930	Chicago, Ill.
American Society for Testing Materials	June 23–27, 1930	Atlantic City, N. J.
Assn. of Scientific Apparatus Makers of the U.S.	May, 1930	Atlantic City, N. J.

National Assn. of Manufacturers of Heating and Cooking Appliances	May 14–15, 1930	New York, N. Y.
National Electrical Exposition	October 6–11, 1930	New York, N. Y.
National Exposition of Power and Mechanical Engineering	December 1–6, 1930	New York, N. Y.
National Glass Distributors Assn.	December 2–4, 1930	Pittsburgh, Pa.
National Safety Council	September 29–October 4, 1930	Pittsburgh, Pa.
New Jersey Clay Workers Assn.	June, 1930	Asbury Park, N. J.
Ohio Ceramic Industries Assn.	May 16–17, 1930	Columbus, Ohio
Taylor Society	May 1 and 2, 1930	Columbus, Ohio
	December 3–5, 1930	New York, N. Y.

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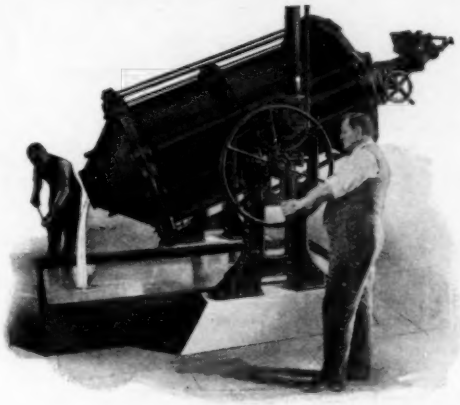

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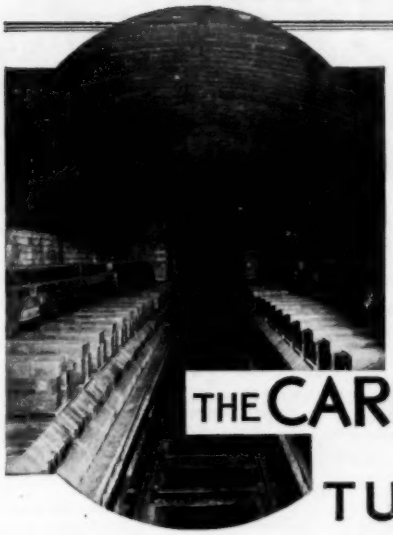

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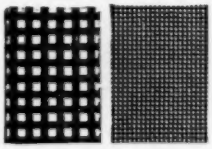

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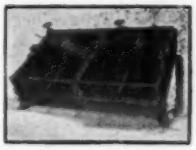

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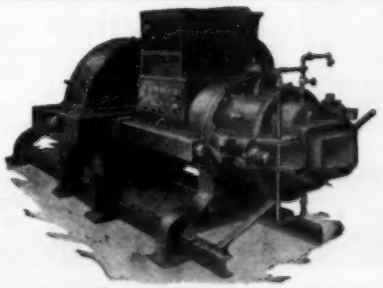

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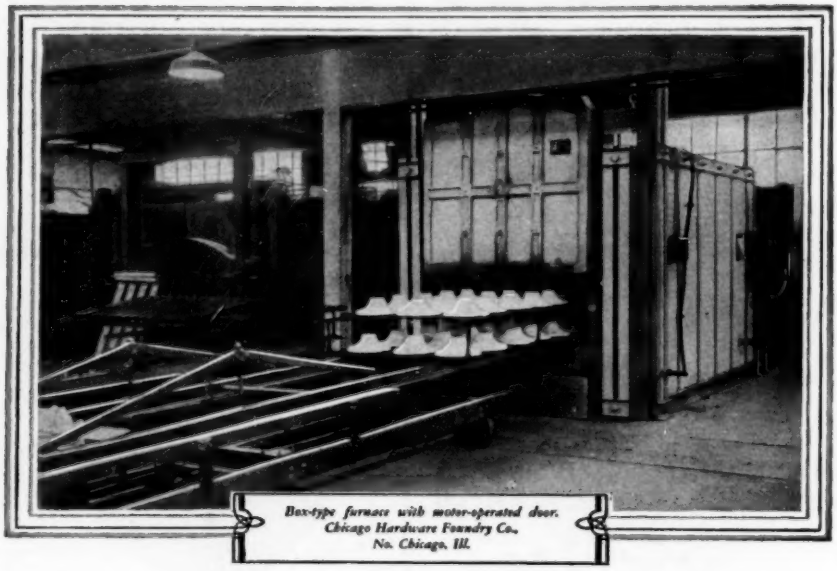

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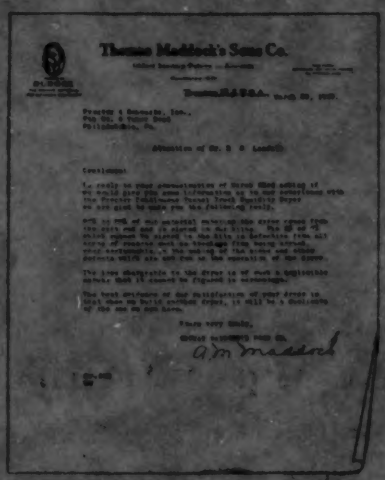

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Journal
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Art Division Symposium

Complete Proceedings
of
Sessions of the Art Division

of the

AMERICAN CERAMIC SOCIETY

at the

Thirty-Second Annual Meeting

Held at the

ROYAL YORK HOTEL
TORONTO, ONTARIO
February, 1930

Preface

This Symposium is being published for the benefit of the manufacturers as well as all artists who are interested in the progress of the development of artistic and beautiful ceramic ware. Special attention is being called to the papers by Arthur Baggs and Marion Fosdick appearing on page 11, and by Harold S. Nash, on page 24.

The SOCIETY wishes to express a word of appreciation to each author who contributed to this Symposium. Special thanks are due to E. de F. Curtis, Chairman of the Art Division, whose efforts have been untiring in planning this Art Division special issue.—EDITOR.

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I. ANNOUNCEMENT

Shortly after the last Annual Meeting of the AMERICAN CERAMIC SOCIETY, the Chairman of the Art Division called the attention of the Trustees to the fact that there is urgent need for research work looking toward close coöperation between the schools of design (especially those offering professional courses in ceramic art) and the producing plants. The United States is producing brilliant designers in some lines of industrial work, but few of them are finding their way into ceramic plants. A considerable part of our ceramic production depends to some extent on artistic design for its appeal to the public but a very small part of that design is supplied by men especially trained for the work.

The Trustees, having approved the report submitted by the Chairman of the Division, invited certain schools, instructors, and plant executives to participate in an investigation to determine the proper technical and artistic qualifications of the industrial ceramic designer. The work has proceeded along these lines by means of conferences, correspondence, and plant studies.

The program of the Art Division at this Annual Meeting is being devoted to the reports of the committee leaders and to a discussion of the plans recommended by them as to the best means of enabling the schools of design to function effectively in the commercial field.

The Art Division earnestly urges the attention of the industrial men; their interest is essential to the success of any movement to stimulate interest in industrial ceramic design.

E. DE F. CURTIS, *Chairman*

II. THE RÔLE OF ART IN INDUSTRIAL CERAMICS

BY E. DE FOREST CURTIS

The object of this paper is to lay before you for your earnest consideration the proposition—industrial conditions in themselves *do not* impose any limitations that prevent industrial ceramic art from rising to the great heights that have been reached in other periods.

There is no doubt that the impression exists, not only in our own ranks but in the public mind, that the factory and art have nothing in common. Each month, on the back of the *Bulletin of the Philadelphia Art Alliance*, which has a membership of perhaps two thousand, there is a quotation from some well-known man. In January, Otis Skinner had this to say:

> Art can never be born out of a machine, no matter how ingenious the mechanism.

That, of course, is true but the general public will not remember and absorb the whole meaning. They will remember, "Art...machine...never,"

and that conclusion is not warranted by the facts. That is a fair example of the trend of public opinion.

This point of view is perhaps logical, for ever since the invention of the cotton gin, about 136 years ago, the trend of industry has been toward solving difficult technical and economic problems, and on the educational side we have developed a public appreciation for painting and the other fine arts as definitely distinguished from the useful arts. This has carried with it the implication that the factory can have nothing to do with art.

If we are to give any serious consideration to art in its relation to industrial ceramics we must first define the meaning of the word "art" so that we shall not confuse it with a mere surface decoration.

"Art" is a much abused word—it may refer to the contents of a museum —it may describe an "art square" of linoleum on sale at a hardware store— it may be used in connection with our most treasured examples of man's expression of his higher self—or it may include a handful of trash. The word alone is nothing to conjure with.

"Art" in its broadest sense is used to distinguish man's activities from the phenomena of nature. A more special meaning is denoted in its relation to aesthetics—the philosophy of the beautiful. When we speak of the fine arts, architecture, sculpture, painting, music, and poetry, we mean those activities in which the end is not use but pleasure, or at least use and pleasure combined.

Strictly speaking, we should only use the term "fine art" when the thing referred to is on that plane. For example, architecture is not classed as a fine art when it is *only* concerned with the creation of a shelter. It is a long cry from the sculpture of Phidias to the current competition for "small sculpture," open to anyone, held under the auspices of a soap manufacturer. There is, too, a long gap between a newspaper rhymester and the truly great Canadian poet, Bliss Carman, whose *Songs from Vagabondia* will always strike a responsive cord in the heart of every man who knows and loves the out-of-doors.

So, here again we find the term "fine art" to be merely a phrase unless it is applied to some object that has sprung from the heart and mind of a creative artist.

Please note that there must be a result to the creative genius of the designer, a product that can be appreciated by the senses. This is particularly true of ceramics. A ceramic product does not exist as such until the thing itself has gone through the kiln and received the final qualities that are only obtainable by that process.

And I submit for your consideration the thought that many ceramic products aspiring to artistic merit and emotional appeal can be made better under industrial conditions than those limited conditions under which the individual must work.

I am thinking of a pair of Chinese pots, made during the Sung period, now in the Metropolitan Museum of Art in New York, and listed in their catalogue of possessions as being of exceptional importance. They are indeed very beautiful. They satisfy every expectation in form, proportion, color, texture, and interest in the glaze that has been imparted by the fire. As they are, there is no quality in them that could not be produced under the best modern factory conditions, except the original conception.

It is this original conception that I mean by "design."

And I dare to hope that we shall be able to train designers, versed in both the art and technique of ceramics who will be able to excel even this great work of the Sung period.

I do not mean to confuse the products of an artist of great ability working alone with those of a manufacturing establishment which is supplied with designs by an equally able industrial designer. The former will always have those qualities of individuality, precociousness, and spontaneity that the nature of quantity production prohibits, while the latter will have the very real compensation of being able to bring fine things to the many. I only want to make clear the point that under proper conditions industrial art is still a medium through which the creative spirit can shine and that it, as well as fine art, can portray beauty.

Regarding the actual production of some of the lovely old Chinese pieces that have been accepted by our museums as standards of excellence, read the account by Père d'Entrecalles, a Jesuit priest, who sent back a careful description of Chinese methods. The piece passed from hand to hand, one man painting birds, another leaves, another eyebrows, and the finished work emerging in all its glory.

Our present-day demands necessary for the growth of an industry are adequate raw materials, suitable machinery and equipment, skilled labor, scientific knowledge of the process of manufacture and the behavior of the raw materials under the influence of heat, proper means of distribution, and a price that permits a profit. Such is industry. For thirty years the AMERICAN CERAMIC SOCIETY has been contributing to the growth of this ceramic industry. It is now an accomplished fact.

And what of art as related to that industry?

The art development has not kept pace with the technical development as evidenced by the fact that even now a great part of our industrial designing is done by outsiders: tableware by decalcomania firms, terra cotta by architects, sanitary ware by the advertising departments of the large plumbing establishments. I do not mean to complain of their ability as designers. I only want to submit the question, "Is it possible for a good designer untrained in ceramic work to rival the work of an equally good designer who understands his medium and how it behaves after it leaves his hands?"

If you have seen the pots decorated by Rodin, you will admit that they are greatly inferior to his work in marble. Compare the beauty of design of a modern airplane with the clumsy early machines. The designer by sticking closely to his fundamental knowledge of aeronautics and materials unconsciously produced a beautiful thing.

So far, our system of untrained designers has here and there produced some splendid work, but as a principle applied to the industry at large, I think that in all fairness I may say we have hardly touched the possibilities.

We believe that it is possible to produce ware that will still the voice of the critic complaining of mechanical perfection, lack of rich color, truly decorative painting, and absence of any distinguished style of ornament.

We believe that it is possible to produce wares that have beauty of meaning and of form with sincerity and fitness of purpose, with rich color and texture, in short, a combination of industrial design that will result in utility and esthetic appeal.

We believe that good design will flourish, as it has in the past, when there are many at work as designers and the public is appreciative. Our present public is most appreciative of the things they understand; we only have to see to it that they do understand.

We do not underestimate the difficulties. There are problems to be solved. If the executive heads of the producing plants, however, once realize that design is a factor in their business and put the same type of research effort into it that they put into their technical problems, great progress will be made. There is only one such difficulty that needs particular stressing, and that is the practice of copying successful designs. Unless we succeed in having real protection from that kind of piracy by legal means, or have an agreement among ourselves not to continue, it will be absolutely impossible to make any headway toward building up our artistic standards, not from any moral point of view, but because it will automatically kill the whole movement.

So much for our beliefs and hopes. And now just a word as to what we propose to do about it all.

The Art Division has been stumbling along for years trying to fit the pieces of this ceramic picture puzzle together. The establishment of two new courses for professional training in ceramic art made the situation acute. Those of us in the Art Division who have had some experience both in teaching and industrial work realize that without study and real coöperation between the schools of design and the industrial executives it would be almost impossible for the courses in ceramic art to function effectively in the commercial field.

Last year we decided that the one thing that would count, and the only

thing necessary, was for us to get the real interest of the industrial men.

With this end in view, under the sponsorship of the Board of Trustees a preliminary study was undertaken, as noted in the first announcement in this report, to determine the technical, artistic, and cultural qualifications for the professional ceramic designer. The reports of the various committees presented at the Toronto Meeting are included in the following pages.

I wish to refer just for a moment to the tableware study.

This work, under the leadership of Arthur Baggs, progressed during the summer to a point where it seemed possible for the Art Division to offer something more than criticism.

The Art Division Chairman, knowing that Charles R. Richards, Industrial Director of the General Education Board, had made a survey of industrial art some years ago, and knowing of his share in the International Ceramic Exhibition, went to him for advice. (I should like to acknowledge here that without his interest and encouragement, we should not have been able to accomplish anything.) Mr. Richards asked whether or not it would help the situation along if the General Education Board were to grant a sum of money to demonstrate to the industrial men the possibilities through coöperation of the school of design and the producing plant.

I will quote from his letter to me of February 10:

DEAR MR. CURTIS:

I am glad to report that the Executive Committee this morning approved an appropriation of $8000 for a grant of $4000 per annum to Ohio State University for a period of two years, beginning July 1, 1930, or as much thereof as may be needed, for the creation of a scholarship in ceramic design applied to tableware, together with provision for research as to technical and market requirements. . . . I sincerely hope that the administration of this grant will be such as to win the respect and confidence of the ceramic industry and lead to continued support of this or similar undertakings.

I suggest that the rôle of art in industrial ceramics is what the industrial men choose to make it. If it be true, as Ruskin said in the *Seven Lamps*, that the arts of a people express their religion, morality, social habits, and national aspirations, it behooves us to consider what we have to express and how we propose to do it.

PENNSYLVANIA MUSEUM'S SCHOOL OF INDUSTRIAL ART
PHILADELPHIA, PA.

III. DESIGN PROBLEMS OF THE TABLEWARE INDUSTRY

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1. Introduction

The information presented in this report is not intended to be final.

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A committee was appointed to collect information on certain points through plant visits and conferences with executives, salesmen, designers, buyers, and stylists. This material has thus been assembled into a tentative report which, it is hoped, will offer suggestions for a thorough discussion by every person concerned in designing and producing tableware. To have this subject discussed from every viewpoint is the purpose of this first report.

We wish to ask the industrial man, especially, to criticize the ideas presented, and to let us know if the ideas seem reasonable to you. Although you may not subscribe to the statements made, you surely favor the spirit behind the effort, which is the attempt to discover how our factories and schools can best contribute to the upward march of American tableware.

The industry has definitely started on its way to better things. Growth and progress will come whether art divisions or ceramic art schools are in the picture or not. But the schools sincerely want to play a part in this development. They can do this if the manufacturers will help them to define clearly the needs of the field and will lend coöperation in working out courses and lines of research which will develop useful men and material for the industry. Our ceramic art schools cannot as yet claim your support on the basis of past accomplishment in tableware design. But, here they are, potential tools for your use. Sharpen them up with your counsel and friendly help. Some day they hope and expect to return real service to you.

2. Need for Improved Design as a Merchandising Factor

Here is a point which seems to need no argument. We have yet to find a manufacturer who does not agree that the tableware industry, particularly the earthenware branch, needs more effort spent on the attractiveness of its product. It is a commonplace of present-day observation that in all industrial lines the consumer is insisting that what he buys shall be not only of good technical quality but shall have novelty, taste, and distinction in its design.

Other industries seem to have been more alert to the general public attitude than have the potters. At least, many of them have more vigorously gone about the business of analyzing public demands and meeting them with the best available artistic skill.

To cite an example: A firm of prominent silk manufacturers has for years maintained a design research staff both in Europe and in this country whose business it is to study style trends with great thoroughness. This staff goes so far as to publish a chart which attempts to forecast for a year or more in advance the popular colors and types of pattern. The retail distributor is also furnished with charts to be used by the sales people in various departments. These charts offer tasteful suggestions for many

accessories of costume which will harmonize with the current mode in silks. These examples are mentioned to show the intensive study which these people have been giving not only to style and design but to aiding the stores to sell their merchandise successfully. In both of these lines of effort the tableware industry as a whole falls far below the standard which other manufacturers are setting. The battle is not over when a line has been placed in a store. An excellent design may be lost unless it is properly shown and its good points are appreciated by those who sell it. One has only to go shopping in the average china department to be convinced that it would pay any tableware maker to carry on a definite educational campaign for building up among sales people a friendly enthusiasm for the merits and sales possibilities of his line.

3. Present Sources of Tableware Design

Until quite recently such a position as art director was almost unknown in American tableware factories. To be sure, Frank G. Holmes in the Lenox plant has been directing its design policy for years with the marked success which is known to all. Some of the leaders in hotel china employed trained artists in charge of design. But generally speaking, the artistic policy of the average factory was shaped by a sort of composite jury consisting of the owners of the plant and the salesmen. The idea of employing a man whose whole time and thought should be given to creative design was radical. An artist could always be secured if one was needed. Most plants employed at least one expert decorator, who could be depended upon to copy ornaments skilfully. Among their mold makers there usually was at least one skilled modeler who could execute molds for new shapes or ornaments if he had a pattern to follow. Splendid craftsmen, these, but usually without training or special ability as creative designers. For the problem of producing a near copy of a popular shape or decoration they filled the bill.

The matter of new decalcomania patterns was also simple. Every so often the decalcomania manufacturers brought out their new offerings. All that was necessary was to decide which ones you liked best and which could be applied most easily to the current shapes. No need of an artist there. The owner knew what he liked and the salesman knew what would sell. An artist would just ball up things. Some truth in that attitude, too, as has been demonstrated sometimes when artists with no ceramic background have occasionally attempted to design ware for production.

This policy seemed to work as long as the public was buying dishes, with utility and price the chief considerations. But the market has become a lot more "choosey" than it used to be about everything, dishes included. Realizing this, the more progressive manufacturer

is beginning to employ a highly trained specialist whose job is to study style tendencies and create new shapes and decorative treatments to anticipate rather than simply to follow market demands. A few of the larger organizations now have art directors who are skilled not only in design but also in the technology of ceramic materials and processes. Other factories are employing special artists for problems such as a new shape or an embossed pattern. These consulting designers as a rule are unused to thinking in terms of ceramic limitations. Their work must be supervised and modified by the practical men in the plant to suit it to quantity production. Good work has been done by some of these artists who have no ceramic background.

Creative imagination and taste are, of course, the essential qualities in a designer. A man possessing these with no ceramic experience will accomplish more than the best ceramic technician who lacks them. It seems obvious that if more designers who have imagination, taste, and the requisite technical knowledge can be developed, they will be most useful to the industry. At the present time such men are few and generally are of English or European training.

4. Typical Design Sources

An inquiry as to the origin of some recently produced shapes and patterns brought out the following examples which perhaps represent average sources of design employed by factories having no permanent art organization:

(1) A dinnerware shape (and a good one) designed by an artist whose profession was painting and decorative design, with no previous ceramic experience.
(2) Decalcomania and print patterns by the same artist.
(3) Decalcomania and print patterns by a designer not experienced in factory production.
(4) Two embossed patterns on dinnerware shapes by a professional sculptor and ornamental modeler with no factory experience.
(5) Embossed pattern on dinnerware by a plant superintendent playing with design in his spare moments.
(6) Embossed pattern on dinnerware by the head decorator of a plant, a man of excellent technical ability and considerable artistic training.
(7) A close adaptation of an old English shape by the head modeler of a plant.
(8) A decal pattern inspired by a line drawing used as a decoration in a current magazine. Someone in the organization recognized its decorative possibilities, clipped it, and sent it to be translated into decal, which was done successfully.

5. Importance of the Decalcomania Manufacturer

Decalcomania patterns are for the most part designed by the staff artists of the decal manufacturers and on them the average earthenware

plant still depends for most of its decorative patterns in overglaze or underglaze.

The decal manufacturers are, therefore, the neck of the bottle, so to speak, in regard to applied transfer pattern in the average plant. Under present conditions, their design offerings from year to year largely determine the character of the current tableware decoration. If the industry is to progress artistically it seems important that manufacturers of decal should be particularly eager to keep abreast or ahead of the style trends.

Their job is a difficult one and while it is easy to criticize such a product, to greatly improve its general standards and at the same time to meet price competition is a problem which would offer plenty of thought even to the most competent critics. Nevertheless, if the industry is to go forward in the use of decalcomania patterns, the manufacturers of this material must make a greater effort than ever before to really lead as creators. They must risk more in pioneering outside the accepted types of ornament, study more intensively the trends of all decorative work, and spend more money for creative designers who can give real distinction to their product. The new notes contributed to tableware decoration come frequently, not from the staff designers of the decal plants but from the outside, whereupon they are eagerly seized and exploited in numerous adaptations which soon are scattered over the whole industry.

The service and reliability of commercial decal manufacturers is said to be good and doubtless they deserve more credit than is sometimes given them by those who find so many decal patterns mediocre and uninteresting.

The problem of making one's own decalcomania prints is difficult and expensive, possible only to a large factory with an output sufficient to keep the decal plant operating steadily. Certain hotel china firms produce their own decal successfully, but probably with no less expense than if they bought it. They have, however, a great advantage in being independent as to delays and in being able to keep close control and supervision of the patterns during development.

The matter of close imitation is one which needs thought not only in considering decal but in all ceramic design work. There should be adequate protection for designs, not only regarding literal copies but also obvious copies with minor differences which are scarcely perceptible. There are, of course, design patents, but how much do they protect?

6. Opportunities for Trained Designers

The question now is whether or not the factories can get the new creative work which they need and must have from the present available sources or is it desirable to attempt to train designers specifically for the tableware field. How many such designers could the tableware plants absorb? Probably, very few at first and only those of exceptional ability. A four-

year university course obviously cannot fit a man or woman to step into a factory and immediately direct artistic policies. But if a talented student can be given fundamental artistic and technical training properly co-ordinated, may he not more quickly become valuable to a plant than can the designer with only art school training?

Only a certain percentage of those who take a course in ceramic art will be potential art directors in a large factory. What is to be the career of the others? These will be students of good general ability, but lacking the rare imaginative spark. They will have knowledge of the design and making of ware, their taste will have been developed, but they will not be creative geniuses.

Is there not a useful opening for such persons in the sales field, provided they have that thing called personality and business sense? Would not such a course be a useful preparation for one who hoped to become a sales executive in a plant or a buyer in a large store?

It frequently happens that a man trained in college as a ceramic engineer develops into the sales end of the industry if his abilities in that direction are strong. Why is ceramic art not an equally good or better stepping stone to executive sales positions in an industry where artistic quality is so important?

American Tableware Is Improving

American manufacturers of earthenware have been severely criticized for lack of initiative and originality in design. It is admitted that much of this criticism has been just. A proof is to be found in the relative space given to American and imported wares of this class in the best stores. Some buyers have made statements that with one or two exceptions there was nothing in American earthenware worth considering for homes of taste. That sweeping indictment, even if it may have been true a year or two ago, is no longer fair. Everyone who attended the last China and Glass Show in Pittsburgh must have been impressed with the almost universal effort shown by the manufacturers to strike out along new lines in shape, color, and types of decoration.

This progress is giving the trade a new respect for American ware. In a recent letter, the buyer for a large city store makes the following statement:

> Domestic ware is becoming more and more popular. The reason for this is that some of the American potters have made wonderful progress in the last two years in quality, shape, and design. Although we still have the biggest demand for English, I think that the time is coming very soon, if the American potter continues as he has done in the past year, when the wares made in this country will be more popular than any other.

There has been a considerable change in recent years in the types of

tableware service sold; fewer large services for general utility and many more short sets for breakfast, luncheon, etc. More and more, today, we are buying dishes to fit occasions or perhaps seasons or moods.

Style changes are much more frequent than they used to be. A good dinnerware shape used to have many years of successful life. Today the demand for novelty keeps manufacturers searching for new shapes as well as new patterns. And the more unusual and distinctive the shape, the harder it is to give it a new dress of decoration which will effectively change it as could easily be done with the more conservative shapes.

This becomes an important matter to consider with regard to disposal of second selection ware. With some of the square and octagonal shapes now so much featured, no type of decoration can mask the fact that it is the same shape as that used for the first-grade product. And if that product is being marketed as a limited, exclusive line, it is not healthy for its standing to put on the market the same distinctive shape at a lower price, no matter how differently it may be decorated.

7. The Price Factor

Cannot better design lift a line out of the price-shaving class? Why must the American potter, when he has created something with real attractiveness and distinction, immediately cut the price to the lowest possible limit in the effort to take business away from his competitors who are making a less desirable line? Will it not be wiser to be content with less volume at a real profit, building up a reputation for quality and exclusiveness and leaving the syndicate business to the huge plants which are fitted to operate on a minimum price basis? The smaller plants, it would seem, should find their proper field in ware which the better department stores will be glad to show, where they now show merchandise largely imported. There is no reason why our smaller plants cannot make such wares; some are making them now. And if they are really fine in design and quality, they will bring profitable prices and sell in reasonable volume. Between wares of decided similarity, price undoubtedly is the deciding factor. But when the customer's fancy is really captured by the notable character of a design or even by the lure of a famous name, small price differences count for little.

Having spoken of famous names, it has seemed that American potters, generally speaking, have been surprisingly little concerned with building up a real personality and public reputation around their names. There are exceptions, of course. Lenox china, for instance, has steadily progressed in the direction of its ideals until it has a personality and a name which are enormously valuable. How many names in the earthenware industry mean anything definite to the average retail customer? It is

true that there are plenty of English names. But if our factories will stop their mad scramble for cheap prices and volume, and step on the design and quality accelerator for a few years there may be several new names which will have a selling power now unknown to them.

In this connection may be mentioned the fact that national consumer advertising has probably been used less by the tableware industry than by any other industry manufacturing a product that goes into our homes. One exception which suggests itself, the Onondaga Pottery Co., is one of the most successful of all tableware plants. Not from advertising alone, of course, but that may be one indication of a general alertness which the industry as a whole has lacked. To be sure, national advertising costs real money, but when backed with a good product it usually pays dividends. Another ceramic group, the Associated Tile Manufacturers, have been doing a good job in national advertising for some years. Importers and distributors of foreign tableware are using increasing space in high class magazines. If we want the American public to buy American ware, we must not only develop outstanding products but we must tell the world about them.

8. Types of Ware Best Suited to Modern Demands

Attention has already been called to the increasing demand for special short sets, informal, gay, and amusing. Wares of this class offer an ideal opportunity for unorthodox experiment in shape, color, and decoration. Novelty, quaintness, "up-to-the-minute smartness" find their best market in this field. Until recently, our manufacturers have allowed foreign merchandise to skim the cream. Peasant ware from France, Italy, Czechoslovakia, and Spain has filled the department store tables. Japanese products of great variety and low price, gay underglaze decorations from England and Germany, plain-colored glazes in brilliant hues and unusual textures have been offered, while we have continued with our slightly varied but basically identical decal sprays, designed with the idea of quick and careless application.

We are improving a lot, however, in our effort to meet this demand for novelty. Plain-colored glazes are applied to shapes designed especially for them. Simple flutings or embossment capitalize the tendency of colored glazes to show variation with differences in thickness. Tinted bodies are being used, giving uniformity of color tone but making possible a warmth and harmony between the ware and its table accessories.

These types of colored ware have been successful, both undecorated and decorated. In most cases applied decoration is more pleasing on these light tints than on the old cold white, and the bands and ornamental touches of platinum or plain color which have been used with them are

most effective. Colored glazes and bodies are by no means developed to their ultimate possibilities.

In this connection may we quote from a letter written by Charles R. Richards, one of the recognized authorities on industrial arts in America:

> I am strongly of the opinion that one line of most desirable advance in this matter of tableware is through color and texture gained through body colors. In my own home, five out of six of the lines of dishes we use on the table are undecorated but depend for their appeal on their color and surface texture. Three of them, all English, have body colors. The other two, one Japanese and one English, depend upon solid glazes. Perhaps the most successful single table service made in England of late years is the undecorated honey buff of Wedgwood, and the most notable thing about the successful ware produced by Sebring last year was the fact that its main appeal is through its body rather than its applied decoration, although the latter seems to me, in most cases, very good.
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> There are excellent opportunities in this direction that are essentially modern in spirit. In the past, outside of modeling, the only method of making table service more attractive was by applied decoration, but the very wholesome and natural opportunities that should be first studied are those that arise out of variations in color and in surface grain.
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> We have a set of plates called "Boffstone," which is a very beautiful thing in both of the qualities last mentioned. I do not know how far reaching the possibilities are in this direction. They may be very limited. But I believe they should be given first consideration in a study of this problem.

Novelty in shape has received much recent attention. American tableware designers have already produced shapes which are definitely in the modern trend but are simple, sane, and smart. It is to be hoped that the restraint thus far shown will be continued. The real sincere contemporary design movement seems due for a long and progressive development and our potters will have an important part in its evolution. But many of the wild superficial attempts which are tagged "modernistic" seem destined for the ash can. We must not be prejudiced against the whole movement by the cheap exploitation of some of its more startling experiments. Good contemporary design is as constructively refined and carefully considered as good design has always been.

While tableware for short sets has been stepping out into new experimental fields of colored body and glaze, novel shape and decoration, there has also been for several years a strong tendency, especially in English ware, to revive the successful shapes and patterns of the past. No doubt the widespread vogue for Early American furnishings has helped to bring about this popularity for the tableware patterns of an older day. Wedgwood, Spode-Copeland, and other factories have reproduced their traditional successes and we must admit that they deserve reproduction and public favor. Many of them have that "all time" quality that makes them stand out as aristocrats in any surroundings.

It would be of no value to the reputation of American tableware to attempt to imitate these products. But we can well study them with care and try to secure in our ware some of the basic refinement which has given these old patterns lasting appeal. There is a growing tendency among American potters to revive the old method of printing from engraved plates. Such prints in single color or with certain colors filled in by hand are most effective and the field should be developed. Underglaze decoration is being introduced in American earthenware and will no doubt be increasingly used for the more exclusive lines. The hotel china manufacturers are producing beautiful work in underglaze decoration. Its use is one of the logical and desirable developments for high class earthenware to work out. Such decorative methods as the use of cut sponges or rubber stamps would seem to have possibilities greater than have been realized.

Texture of glazes will offer a field for experiment. Already matt glazes are being offered on tableware. They are pleasing to the eye. How the public will react to the absence of the familiar glassy smoothness of the traditional glaze remains to be seen. Salt glaze, which once was used beautifully on English ware, is being revived by Mintons. It is a time for experiment and there are doubtless real hits to be made by those who search hard and intelligently for the unusual and tasteful in design and its application.

9. Training of Ceramic Designers in Schools

What general and specific training will best fit the prospective designer to function effectively in the industrial plants?

We shall assume that the wisdom of attempting such training is granted. Enough persons have favored the idea to bring about the establishment of such schools believing that they can at least furnish a start in the right direction. Everyone must admit, however, that before even the most able student can become a real industrial designer he must add to his school foundation some years of plant experience.

The following subjects should therefore be stressed in training ceramic artists.

First of all, design; if a student were to study nothing else for four years he could not get enough. (1) He needs historical design, studied especially through ceramic products but also in a general art history course so that the conditions and environment producing the various developments in style may be understood.

(2) Still more important is creative design, studied not only in the abstract but in definite practical application to product, illustrating and giving technical practice in the various forming and decorating processes.

Only by attempting actual production, unskilled though it must be at first, will the student register clearly the possibilities and limitations of his medium and begin to think in terms of ceramics.

This study of design, historical or contemporary, should emphasize the influences which shaped and are shaping the styles. The student should learn to keep his eye not only on the current ceramic products but on architecture, interior decoration, painting, sculpture. The prosperity and manner of life of the people, how they think, work, play, and entertain their friends, all have a bearing on the type of ceramic ware which can be sold to them. The designer who is to lead styles must study his surrounding scene.

Drawing, both freehand and engineering, modeling, painting, these are his practice scales in learning to express his ideas. Without these developed to a reasonable degree the designer is sadly handicapped. But there are many wonderful draftsmen and modelers who never had a real creative idea in their lives. The indispensable quality in a designer is imagination. Sometimes your hard-boiled manager or salesman has it and, although he does not pretend to be an artist, contributes an occasional winner which is worked out in detail by others.

So far most persons would probably agree. Thorough study of design, as much skill as possible in representation, development of imagination and taste; our ceramic artist must try to get these. But there are other subjects about the value of which to a prospective designer, we may not all agree.

(3) How much of a ceramic technologist should he be? Should he study the composition of bodies, their preparation, and forming processes? Should he go deeply into the fascinating field of glaze and color composition or should he concentrate on processes of application and leave composition to the technical specialists? Should he study ceramic calculations; be able to figure batches from formula and back again? Should he attempt with his own hands to throw on the wheel, jigger, cast, press, make molds, blocks, and cases, set, fire, and draw kilns?

(4) What emphasis should be placed on problems of marketing, cost limitations on certain classes of ware, and similar points?

He will have to consider all those things when he is designing for production. Should he not at least begin to sympathize with the problems of the sales department while still in school?

If a designer were being definitely trained for a certain branch of the industry, as tableware, for instance, a more specialized course could be given. But a general course must be such as will give a fundamental introduction to any field from tableware to terra cotta. We must then, it seems, search for the essentials of each specific branch and give these fundamentals to all.

Unless a student definitely knows in what line he is going to be employed it seems that specialization should be deferred to a graduate course. After the general course, supplemented perhaps by a year's experience in a factory through the coöperation of manufacturers, an ambitious student could return to college for a year of intensive study in a particular field.

No one school could afford to offer such specialized courses in every branch of ceramics. But if the field were divided, one school giving graduate work in whiteware, one in glass, one in terra cotta and tile, etc., opportunity could be given for the eager student in any line to increase his usefulness greatly through a year of specific concentration. An experiment in this direction is to be undertaken next year.

10. A Fellowship in Ceramic Art

Due to the vision and hard work of our Art Division Chairman, Mr. Curtis, a plan was launched last fall to obtain some means of financing a special tableware study in connection with one of our ceramic art schools. Mr. Curtis succeeded in interesting Charles R. Richards, Director of the Division of Industrial Art of the General Education Board. Several prominent tableware manufacturers lent helpful coöperation. The weight of their approval with that of the AMERICAN CERAMIC SOCIETY through its President, Secretary, and others, convinced the Board that the idea was worthy of support. A grant of $4000 per year for two years has been made to Ohio State University for the creation of a scholarship in ceramic design applied to tableware, and for research as to technical and market requirements.

While the details of the study have not been worked out the tentative plan may be outlined for suggestions and comment. It is proposed to give this scholarship to a young designer of marked creative ability, initiative, and energy. This man will give full time to the work and under direction will be responsible for its steady progress. His efforts will be supplemented by contributions from other students and instructors. At times the whole ceramic department will study various aspects of the problem. The design classes of the Fine Arts Department will be given opportunity to work on it.

The best results of these combined efforts will be carried out with the collaboration of expert factory operatives who will be employed at the school for certain periods. A more professional character in execution will thus be given to the work produced. Students will also gain inspiration through contact with these expert workmen.

It is hoped to maintain throughout the study a close contact with the factories, proving out experimental results under plant conditions when-

ever it is possible. Two factors are vital to the success of this undertaking, however it may be directed.

(1) The selection of the best possible design student.

(2) The assured coöperation of the industrial plants.

A nation-wide search may well be made for a young designer of real promise who will see in this opportunity something beyond the comparatively small salary involved. The right person must be found. Factory coöperation will not be lacking, judging from the way in which the project has already been supported by industrial men. Some ways in which the manufacturers can help are these:

(1) By allowing those engaged in the study to make frequent visits to the plants, observing production methods and receiving the benefit of the practical experience of plant executives and foremen in meeting some of the problems which will develop.

(2) By lending various skilled tradesmen to the school for certain periods during which their salary and extra expenses will be paid by the school.

(3) By furnishing for experimental uses at the school certain standard articles in various stages of production, such as plates in greenware, bisque or glazed; also, possibly furnishing occasionally a quantity of prepared clay, special saggers, or other equipment.

(4) By firing in the factory kilns from time to time, test material which the school wishes to prove out under plant conditions.

The Art Division, thanks to the splendid work of Mr. Curtis, has started something which one of our schools is elected to test out. It is a great opportunity to prove that we are all of some use to each other if we will pull together.

Further Considerations

As a part of the work of this committee when finally completed, it is hoped to compile a review of tableware production and decorating processes giving in condensed form the essential information about each with special reference to the limitations which the process imposes on design for quantity production. Some of the features which designers must consider when ware is to be produced at minimum cost will be noted. With help from the practical plant men a brief text book of tableware production processes can be worked out which should be valuable to prospective designers. A beginning has been made but we shall not attempt to present any of this material at this time. Factory men have already been most willing and good natured in helping to make such knowledge available. We shall no doubt call upon many persons to lend still more aid in the further development of this part of the Committee's program.

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IV. THE PLACE OF DESIGN AS A MERCHANDISING FACTOR IN THE GLASSWARE INDUSTRY

By Harold S. Nash

As the result of a recommendation made by the Chairman of the Art Division and approved by the Trustees of the American Ceramic Society, a study has been made of the rôle of design as a merchandising factor in the glassware industry. It must not be expected that a committee acting with limited time and resources at its disposal could settle all the problems involved. This report is only preliminary. Certain suggestions toward solutions and recommendations for further study are made. The author is not unduly optimistic about the suggestions being accepted generally because, with few exceptions, respect for creative ability and understanding of what creative design really means are not strong enough to command aggressive effort in that direction.

Design as a merchandising factor is too often accepted as something that needs no particular thought. It must be true that the type and character of glass on the market is saleable and profitable or there would be more aggressive interest in adding to its freshness. But it will do no harm to say that if the same superficial understanding held good in technology as it does in design as it is practiced, the glass industry would be in a very unfortunate state technically. Our purpose is to present a constructive report, but it is evident that there can be no construction if the client sees no reason for improvement. Industry has dug and will continue to dig for technical control and efficiency at the cost of infinite labor and research. In design a lucky guess or a close copy of the next man's best seller seems good enough.

It seems reasonable that if there were any possibility of putting the problem of design on the same basis as the chemical and mechanical sciences, manufacturers would be the first to take advantage of it. They are scarcely aware that it could be done. Principles of color would be interesting if, for harmony, there were mathematical proportions of hues, intensities, and tones. There are such charts, helpful as a means to an end, but there are sound reasons why they cannot, or at least, should not be anything else.

I do not wish to be pessimistic, but I do believe that until the whole industry, or most of it, comes to recognize that design has principles as real and sound as those of mechanics and like those of mechanics suf-

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Acknowledgment should be made of the courtesy of such firms as the Fostoria Glass Co., the Roessler & Hasslacher Chemical Co., the Lynch Glass Machine Co., the Miller Machine and Mold Works, and the Wm. J. Miller Co., Inc., in coöperating with this work. It is quite likely too that there are others who would have been glad to give assistance had they been asked.

ficiently important to keep whole research laboratories definitely employed in applying them, we shall go on believing that we know what design is.

Questionnaire Returns

To nine letters written to trade associations for their reaction to the study of possibilities of design as a merchandising factor there were five replies. Of these replies, one from the Mirror Manufacturers' Association felt that there were possibilities for fresh ideas in that field. The associations of the window glass manufacturers and the plate glass manufacturers feel quite reasonably that there is little place for designers in their field. The Glass Container Association rather discouraged the idea of new designs. There were no replies from the other associations. Such a statement does not necessarily imply that some members of these associations are not interested, but it does suggest a lack of organized interest.

Plate Glass The Plate Glass Manufacturers feel that esthetic design plays a negligible part as a merchandising factor in their industry. Attempts at standardization, they report, were made several years ago in coöperation with the Bureau of Standards at Washington, when Federal Specifications No. 123 covering polished plate glass were prepared and adopted. A national advertising campaign conducted by their Association for six consecutive years, 1921 to 1927, was discontinued for a plan of having special representatives call on prospective purchasers. The latter plan is reported as being more effective. The Association had nothing to say about foreign competition.

Window Glass The window glass manufacturers feel quite the same about design as the Plate Glass Association. Their chief concerns are standardization of size, weight, and quality, and the meeting of competition from imported goods, chiefly from Belgium and Czechoslovakia. The Association has no permanent committee to study and report on new possibilities for glass, but consideration is being given to the question of having an organized study made of these possibilities.

Glass Containers The Glass Container Association of America does not include esthetic design as one of its activities, feeling rather that in an industry in which standardization is an important element, new designs should be discouraged. A new design in one factory compels other factories to adopt it as well, the result being an increased cost to all concerns, and no advantage. The exception seems to be the perfume bottle branch of the industry in which members coöperate in standardizing some shapes, but patent others for their exclusive use. Competitive materials are tin, cellophane paper, and to some extent paper containers. The Association reports a serious problem of imported perfume bottles, the bulk coming from France and Czechoslovakia;

and an approaching problem of common bottles and glass carboys from Germany. The Association sponsors a national advertising campaign under the slogan "See What You Buy—Buy in Glass." Special designs are adapted by mold experts from designs submitted by purchasers. Stylists are employed occasionally for some work, but there are probably no full-time designers in the esthetic sense employed in the industry. The Association has a permanent committee on new uses of glass bottles.

It should be pointed out that among common bottles and containers are some of the most genuine expressions of esthetic design. There are objects that describe their function beautifully: the clear transparency of the material and its fitness as an inert substance in contact with most chemicals; simplicity of form in character with its direct purpose; starkness that fits honestly the swift certainty of their inception. It should be pointed out, too, that if there are mistakes in some containers, the error often lies with someone outside the factories.

Esthetic design does not mean to doll up an object with ornament. It can capitalize an entire absence of ornament. It need not avoid standardization if standardization seems desirable. If an object is to be standardized there is all the more reason why it should have a character which will not bore with endless repetitions. And the simpler the better. It must be borne in mind, however, that importations are characterized by variety and freshness of design.

Perfume Bottles Replies from users of perfume bottles vary in respect to their opinions on the relative merits of foreign and domestic packages. Some users will not commit themselves. Those who do, agree rather consistently that their choice is not a question of price. Some feel that they can be served as well here as abroad if they furnish their own designs, and some are of the opinion that in the design field foreign bottles are far superior to domestic ones. In spite of the fact that the Association feels that a study of factors surrounding the design situation, other than those of standardization, is hardly important, the Association is too courteous to mind my disagreement. I feel that it is of great importance not to push any propaganda for change, but to ask its coöperation in a study of production methods here and abroad as a basis for further opinion. It may be that there is a false economy in making all objects too economically on a big machine.

Mirrors The reply from the Mirror Manufacturers Association confirms the stand taken by the Plate Glass and Window Glass Associations, that in plain plate and window glass there is little room for expression. Rolled glass has tremendous possibilities, but with its present limited use realizes only a few of them. The possibilities of rolled glass as well as window and plate glass lie not so much in changing design of the material as in design of uses for it. Some of it is beautiful.

It is in the design of mirrors and the use of mirrored glass that the Association is interested. The Association does not sponsor any advertising program or consult any authority in the design field in the interest of its members, although some steps have been taken toward such a program. Neither has the Association any permanent committee to study and report on new possibilities for glass.

Table and Decorative Glass

It is something of a hazard to speak for the manufacturers of table and decorative glass. There are a few outstanding firms who are fortunate to have men in charge of design who have the rare qualifications of being both artist and technician. These men are the finest examples of what mere glass designers must become to suit present conditions. Other firms employ stylists and free lance artists for their designs. Some of them are much interested in any attempt to help make design a competitive factor, and would coöperate in any reasonable program toward that end. And of course a great deal of ware is not designed at all in any creative sense.

Principles of Design

It seems worth while to outline again some major principles of esthetic design as they may be applied to glassware. They are as concrete as the principles of mechanics. Plus the principles of design and mechanics, however, there must be a peculiar type of imagination to use them. If the care were given to the selection and fostering of people who can use design principles as there is given to people who can get results from an imaginative use of mechanical and chemical principles, we would have a real art and a profitable one.

Glassware design may be summed up in five principles, each of which has its own ramifications.

(1) Pride of Material: The object must aggressively capitalize limitations and attributes peculiar to glass, such as transparency, translucency, refraction, reflection, diffusion, plasticity, resistance to liquid penetration, resistance to chemical attack, etc.

(2) Pride of Function: By a skilful selection of natural qualifications of glass and an imaginative use of form, color, and texture as they are natural to glass and practical in the light of the object's use, the object should attain a character natural to, and descriptive of, its purpose.

(3) Style: The object must have a character or style sympathetic to the surroundings in which it is to be placed, and satisfying to the intelligence of the purchaser.

(4) Pride of Manufacture: The object must carry, unashamed, a spirit and feeling consistent with the tools and methods responsible for its creation.

(5) Creative Imagination: The object must have a freshness over and above these limitations successfully met.

Besides these specific principles there should be mentioned general

principles apparent in any work of art, such as contrast, balance, unity, scale, and rhythm.

It might be well to distinguish between a modern philosophy of design and a philosophy of modern design. The outline I have given covers broadly a modern philosophy of design. Its distinction lies in the fact that its principles may be followed to produce articles that belong to other periods than the contemporary one. A philosophy of modern design involves simply the further addition to the third principle of style, that the character or style of the object must be sympathetic to modern surroundings and the modern frame of mind.

Source of Inspiration

If factories wish to do things in a modern way there is no better or easier source of the spirit which the objects should possess than in the factories themselves. The source of the modern spirit is in industry and science, and it is from them that we shall create an art of our own if we ever do, rather than from European inspiration second hand: dynamic rhythm of machinery, sweeping elimination of waste movement, a scientific principle explaining a thousand facts, stark function, character instead of cheap sentiment. Industry is modern art and does not seem to know it.

Basis for Form There is still no mathematical basis for glass form. It is true that there may be a mathematical formula for classical form. But it is equally true that the classical forms are far removed from the plastic quality of glass or clay either for that matter. As a matter of fact the Greeks actually avoided in their crafts both glass and glaze. Any formula for abstract form may be helpful as suggestion, but until there is a formula for glass form, wood form, metal form, and for all the materials, a formula may do more harm than good.

Function of Patterns The function of pattern seems to be misunderstood, or rather its least important aspects are over-emphasized. Pattern is often thought to be a synonym for design. A pattern may attract interest for its subject matter, its story-telling quality. It may attract attention because it brags of the amount of labor or skill involved in producing it. And it may attract a momentary awe because of a bewildering confusion of effect that acts upon a spectator like extravagant language which he does not understand. Both become tiresome after the first contact. The two most important functions of pattern for glass are (1) to emphasize the glassy nature of glass by accent or contrast (relief, cutting, etching, sandblast, etc.) and (2) to break up a plain area into interesting spaces. It may also serve in a functional way to accent direction, render window glass proof against vision, distribute light in a determined direction, bring objects into scale with

surroundings, etc. There is nothing wrong about employing association in a pattern as a part of its interest. But it must be quite secondary to the two principles mentioned. Pattern must first of all be a part of the object structurally.

One of the most noticeable characteristics of contemporary expression is a certain stark quality, simplicity, lack of detail. This is most logical. It should be noted, however, that a simple object is not necessarily an obvious one. A great man is usually more simple than a lesser one, but he is not obvious. There is a fine distinction between the two, and it is one that should have a better understanding in the industry.

Draftsmanship or Ability to Design

The popular conception that a good draftsman is an artist or designer still seems to hold in the industry. It has done a good deal to ruin the prospects for an American art. The ability to draw is more unusual than the ability to write, but basically is of no more consequence. Draftsmen who can arrange flower forms or motifs from a book of ornaments are common and cheap. Artists and creative designers who can give birth to an idea and carry it consistently through material, process, and use, to a unified personality to which every limitation of manufacture has added value, and on which no waste superficialities have been imposed, are rare. Draftsmanship design is comparable to mixing a dozen random liquids including nitric acid to etch a steel plate, and being compelled to use them all because of ignorance as to what liquid is doing the work. Until industries employ men with creative imagination who can build up design from foundation principles along with an intimate knowledge of glasshouse practice, we shall continue to have imitation and plagiarism. Plagiarism is not just a matter of ethics. With fresh things coming from abroad it is suicide.

Color in Glass

There is much to be said for color in American glass, and for absence of color. Both aspects have their place. Colored glass has possibilities untouched. Prevailing practice employs light tints of pure color, and they fill the demand of the less imaginative purchasing power which is not small. There is a market beyond that, though, smaller but worth while, that American colored glass has not touched.

Purity in itself is not a characteristic of modern times, and it does not make for imaginative interest. There is an element of dissonance in modern expression that glass color has not caught. It is the element in modern music that supplies the thrill; it is the unexpected twist to a crime club novel just before the solution; it is the unusual person who is as sound as anyone after you get to know him; it is the ugly duckling who turns out to be a swan. There are subtle "off" colors that can supply that interest to glass.

There is also a very definite field for research in texture and color rhythms of foods in relation to glass. Coffee with cream spoils the color of a transparent green cup. The offering is not inviting. A translucent or semi-opaque green glass would accent the richness of the coffee color without being destroyed itself. Opaque liquids in a general way require a semi-opaque glass or a transparent glass of an analogous color. A salad using lettuce behaves beautifully on a green transparent plate. Besides the rhythm of color, there is an added rhythm from the transparent plate through the translucency of the lettuce to the semi-opaque quality of the rest of the salad. Further, different colors carry quite different characters, and people of perception feel the inconsistency of a bold, stark form colored a sentimental pink. Color offers important possibilities in defining styles and characters for numberless purposes.

Style in Design

There are many style possibilities in glass design that have not been used. Two popular notions of style do no good. One prevalent idea is that style is the superficial aspect of an object based on whim. One china manufacturer makes a plate with stark, spear-like shafts entering the center from the rim, righting the first shock of dissonance by the lovely arrangement the thin lines make when the table is set with the plates. The manufacturer has caught a style or character. A colored body instead of a glaze makes for a little hardness in quality. The straight unyielding directness of the pattern brought abruptly from the rim accents the strength. The pattern is in one color, nothing sentimental to destroy the breath-taking simplicity. He has caught the character of sophistication. And to keep it from being inhuman, the table arrangement allows the pattern to be scattered just carelessly enough to prevent any unpleasant tight quality. There is a reason for everything.

When a dozen other manufacturers feel compelled to copy the style they copy nothing but superficialities. It is true that they run pattern from the rim to the center, but of soft rounded forms in sentimental colors. They express nothing but a lack of imagination and some other more unpleasant things. Human characteristics may be expressed as style, but only as every element in a design lends itself to the result desired. Because a thing is new or different does not in itself create a style. A real style can be analyzed and described in terms of character, and not in appearances only. Styles to suit moods, times, character, food, and clothes are possible and are economically sound. Styles for no other purpose than to displace other styles are wasteful and destructive.

What Is Design?

Design is not the obviously simple thing it passes for, and it becomes less simple every day. The first and most important thing that can happen

to American glass industry from a sales point of view is a general realization of what design is, and a respect for its possibilities if real designers can be developed.

A real designer should thrill to the beauty of the material itself in order to capitalize the qualities peculiar to it. He should understand that primarily an object is built for use. The sincerest kind of design is based on function. He should have sufficient background in history, history of art, and in social contact to understand the meaning of tradition in relation to the types of mind that produced it. He should know which elements of tradition are applicable to modern times, and which are outworn. He should be able to read from contemporary life and from materials other than glass, styles interesting to contemporary thought, and uses pertinent to modern methods of living. He should love machinery as well as the skill of hand workers and he should be able to distinguish between the kinds of expression belonging to each. He need know little of the actual manufacture and adjustment of molds, but he should understand the principles on which their limitations are based. He need not know much of the construction of leers, but he should have a working knowledge of strains caused by unequal masses of glass and prolonged processes between the glass pot and the leer. He should learn to weigh and understand every phase of glass practice divorced from glasshouse tradition for its design possibilities. He should study modern tools and methods for their own inherent possibilities and not to imitate weakly the nature of others. He should be able and willing to follow ware through production to check up on deviations from the character it is planned to have. He should be a thoroughly practical man with resource, inventiveness, esthetic judgment, and ability to handle labor. He should sense the difference between simplicity and obviousness, between ostentation and elegance, between character and cheap effect, and he would be a most difficult man to find.

Designer Must Know Ceramics

The greatest handicap of the designer is that he does not understand enough of actual glass practice to make his designs conform to profitable practice. The remedy lies with the experienced glass men in the industry by helping to make available to designers and prospective designers of glass an understanding of production principles to which profitable design must conform.

There is quite a bit of printed information on glass and glass processes available, but it is scattered and it carries a great deal of detail that is not pertinent to the understanding a designer need have of glass. Such material might be edited and correlated for the material relevant to the purpose in question, and the gaps filled in with first-hand information

from the industry. If there are books for the training of retail salesmen, there is no reason why there should not be one for the designer. The idea of such a compilation would not be to furnish working details for carrying out the processes, although it might carry a selected bibliography of such directions. It should endeavor to reduce practice and process to the principles that determine whether a design is merely possible or practical. It should be thoroughly illustrated with photographs of consecutive steps in the production of representative objects, and it should contain illustrated explanations of the result of violation of principles whether the result be bad ware or prohibitive cost. Such a book, if it could capture the principles of production in relation to design would be of value not only to designers but to students specializing in technical control.

Suggestions

The entire glass industry is not actively interested in design as a merchandising factor. The Art Division could offer distinct advantages to any part of the industry that is interested, but the Art Division has too few active members to attempt any worthwhile program in this direction without the definite coöperation of the interested group.

It is suggested, therefore, that a tentative program of the Art Division in the interest of glass design be formulated and distributed to all glass manufacturers in whose product the element of esthetic design might be considered a merchandising factor. The program should contain constructive steps to utilize the merchandising possibilities of a truly creative type of design. It might set forth advantages accruing to firms subscribing to it, as well as obligations that might reasonably be expected of such firms. On this basis a self-selected association of glass manufacturers willing to coöperate in an effort to establish a sound basis for competitive design might be formed within the Art Division.

One general purpose of such an association would be to furnish studies of specific principles of design to subscribers, interpret style trends and possibilities in the light of contemporary expression, suggest new uses for glass, provide opportunities for disinterested criticism of proposed new designs, provide a link between schools of design and factories, constitute a bureau for the sale of designs, and make possible a unified organization representing different branches of the industry to protect and advertise common interests.

Such an organization might include the following suggested activities:

(1) To edit published matter on glass production, as it is related to the designer's need, and to gather such additional information as may be needed to fill in the gaps.

(2) To establish a library of lantern slides in the office of the AMERICAN

CERAMIC SOCIETY, covering representative equipment and processes in the glass industry.

(3) To encourage the production of a motion picture film representing the glass industries in the association.

(4) To provide well-written, illustrated talks for women's clubs and courses for such organizations on appreciation of glass.

(5) To provide boxed exhibitions of glass materials and glass products for schools and museums, with accompanying explanations and photographs of processes.

(6) To encourage manual arts courses in glass for grade and high schools, and to publish in the manual arts magazines problems suitable for such courses.

(7) To encourage in the trade journals more articles dealing with principles of production, such as the articles on glass molds by Roy Swain in *Glass Industry*, and to encourage more articles in trade journals on principles of esthetic design.

(8) To establish the procedure of putting schools of design on mailing lists for catalogues of products, announcements, and catalogues of glass-working equipment.

(9) To encourage actual problems in glass design, submitted by factories to schools of design.

(10) To provide subscribers with studies of principles of design as they are pertinent to suggested styles, limitations of production, and honesty of material and technique.

(11) To provide opportunity for schools of design to submit designs to practical men in factories for criticism.

(12) To provide short courses in appreciation of principles of design for factory men, by colleges.

(13) To encourage an interchange of talks by practical producers of glass and teachers of design. Such a program might conceivably be made of interest to a great many employees in factories, and from that standpoint alone be worth while to manufacturers. From the school's point of view, talks by glass men would be invaluable.

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V. ART POTTERY

BY MYRTLE MERITT FRENCH

Introduction

To obtain material for this paper the writer has consulted designers, manufacturers, wholesale buyers, sales people, and consumers. It has not been possible to confine the inquiries to the ceramic field entirely when interviewing the designers and manufacturers, because only a few art potteries are near. It is fairly safe, however, to believe that the attitude would be about the same in all fields.

It is gratifying to those interested in industrial art to see that the most

progressive manufacturers in all fields are recognizing the value of art in industry and that most creative artists are realizing the great opportunities in the industrial field. They find that it takes even greater ability to design successfully for industry. Through the coöperation of the artist and manufacturer, industry in this country has greatly improved the art quality of its products during the last few years.

How Some Manufacturers Are Proceeding

The manufacturer and artist should work together more closely. This is being accomplished in various ways. Certain firms hire designers to work half a day and allow them to go to art school the other half-day to work on problems allied to the requirements of the company.

One firm at first skeptical of the changes recommended by their artist was persuaded by the good logic of the designer to try out his ideas in one piece. The result was a huge success. Since then other improvements have occurred and the company is now making expensive changes in machinery to get more beautiful proportions because better design increased the sales to a great extent. Another company is looking for a trained designer but does not want its competitors to know that better design will be introduced.

In contrast, one manufacturer was found who has an untrained designer. New samples are often made from pieces purchased by the manufacturer, instruction being given to change slightly before producing. A salesman being questioned about that particular product said, "Of course it is not really beautiful, for it is too unimaginative and uninteresting." A prospective consumer was pleased with the first glimpse, but after trying to choose a piece became so tired of its lack of character that she left the store without buying.

Stealing Designs The practice of stealing designs is disheartening to the buyers and to the creative manufacturer. One manufacturer who produced beautiful original ware expressed a feeling of futility in his effort to make fine design because unscrupulous people, producing less expensively, make soulless copies and steal his business. A consumer with little money will buy the cheaper, less attractive copy, while one with money to buy the best will not do so because of the monotony of the copies. The manufacturer who originated the designs seems to feel that there is no use trying to make creative things in the United States because of this practice. Importation, as a result, will supply the demand for beautiful things.

Some united action should be taken in this country to boycott design parasites or to get a more effective protection through the patent office. In certain countries of Europe a company can be brought to law for making

a design which is very evidently a steal, though it may be changed in several details.

Kind of Designers Needed

Too often artists have felt superior to the manufacturer and have thought that they should sacrifice utility and natural production to "beauty." As a matter of fact, utility and logical production are the first requirements of beauty, and a designer clever enough can combine the three. That is the kind of designers industry needs.

Some of the manufacturers interviewed have not been especially concerned as to whether or not designers know the methods of production; others have felt it very necessary. One preferred that they should not know them thinking they would be more likely to undertake new things, thus bringing in a more creative note which the business could help to make practical.

In general, the feeling seems to be that a designer for industry must know the basic principles of design, something of his material, and have a mind which easily grasps simple mechanical principles; added to this, keen observation, active imagination, and ability to present ideas clearly, either in material or well rendered on paper, are necessary. The writer would add to these requirements that he could be a better designer if he kept in touch with progressive interior decorators and wholesale buyers to know their needs, if he tried out the use of the objects he proposed to put on the market, if he kept himself familiar with social customs and needs, and if he experimented with very simple mechanical devices.

A craftsman should be more individual than the manufacturer in what he produces, but his ware should be practical. Craftsmen are much more likely to make impractical pieces than is the manufacturer. In all the branches of art pottery there is a tendency to spend too much money and energy on decoration with too little thought about form. It is well to remember that every article adds detail to the room it occupies, and that often decoration of strong contrast is confusing, especially if not structurally handled.

When in doubt it is always safer to leave a piece undecorated than to run the risk of having too much. Primarily, pottery is for use and that idea should be kept uppermost. If decoration adds to its beauty it may be permitted, but it should never be added at the expense of form or use. Simple mechanical devices have great possibilities for the craftsman, such as the block printing process.[1] Some craftsmen consider all such devices beneath their notice. The ancient craftsmen, however, did not and their work is treasured in museums. The craftsman, especially, and the manu-

[1] S. Loshinsky, "Linoleum Block Printed Pottery," *Jour. Amer. Ceram. Soc.*, **12** [7], 502–504 (1929).

facturer to some extent, forget to design a piece to look well in use. Too often the piece looks right as an abstract article but when it is put into use it is unattractive. To illustrate, a flower pot should be designed with the thought of a plant in it, a lamp base with the shade on it, and a flower vase with flowers in it. Sometimes the shape and proportion do not seem especially pleasing when not in use but are exceedingly lovely in use. A thing which will attractively serve more than one purpose is all the more valuable.

Probably the greatest contribution of those engaged in teaching industrial ceramic art will come through an open-minded, practical, sincere experimental attitude, emphasizing technical principles in class work, but encouraging the working out experimentally of original ideas, though at times they may promise to be impractical. A good student who will succeed is usually as intelligent as the teacher, though less experienced, and that intelligence should be respected and encouraged by assigning problems requiring vision and initiative in handling materials creatively. The poor student should be discovered early and helped to a field for which he is better suited.

Those teaching industrial art would be better teachers if they would teach less and create more, especially for easy reproduction. This does not mean that they should necessarily have fewer scheduled hours but that they should teach less forcibly and create more freely, giving the students credit for having intelligence to create independently most of the time, and encouraging them to do so.

Criticism of Designs on the Market

A few concrete changes have been suggested by those interviewed. Glazed flower pots are considered too ornate and often very bad in color. Those more individual and attractive to look at are frequently not the correct size to receive any of the standard sized porous pots. The use of these porous pots inside the glazed pots is usually considered better for the welfare of the plants. Lamp bases are likely to be unstable when fitted up with shades and fixtures but with colors not harmonizing with interiors being used. The demand is for lamps mellow and full of color quality that they may hold their own in a room without becoming too gaudy. Flower holders have three faults. The holes are too small for the stems of flowers used most frequently, the holders are so light the flowers tip them over, and the holes are so shallow the flower is not held upright.

There has been a request for larger pieces which could be used in big rooms. There seems to be plenty of pottery around eight, ten, and twelve inches, but very little of larger dimension. There have also been requests for attractive garden pottery which could be used practically, and for more

personality in the pottery already on the market. Flower vases were criticized as having too small necks to take the flowers loosely or as having too little space for a sufficient water supply.

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VI. DISCUSSION CONCERNING THE NEEDS OF THE TILE MANUFACTURERS FOR SCHOOL TRAINED DESIGNERS

BY PAUL E. COX[1]

Through the suggestion of the Chairman of the Art Division a questionnaire was sent out by the writer to a few tile companies. A specimen inquiry read as follows:

I am requested by the Art Division of the AMERICAN CERAMIC SOCIETY to find out what is thought by manufacturers of tile of the courses of study that ought to be offered in our schools to train young people so that they will be of service in the design work incident to your kind of business.

You are probably familiar with what is being done at Ohio State University in developing a course of study. You know what is being done at the New York State School of Clayworking and Ceramics on the same sort of thing. Your attention has also probably been drawn to what is being done at the Art Institute in Chicago and at the Cleveland School of Art.

It is our thought that possibly some of these schools are doing exactly what ought to be done and we are interested in proposing some sort of plan which will yield young persons who are competent to fill ultimately the sort of jobs that are generally filled in this country by men who come from foreign countries. The whole scheme of education here differs so greatly from that of Europe that it may not be possible for us to accomplish any good.

A brief statement from you of your opinion on what ought to be taught would be helpful and greatly appreciated by the writer.

No effort was made to reach the studio type of tile plant since these companies are operated by persons who have gone into the work for the love of good design and good taste in color. Their products speak for themselves.

Mr. Curtis has commented that many times the architects buy from these smaller companies in spite of slow delivery, because of the superior quality of their product, due to the fact that good designers have worked at the production.

This point is one that should be discussed most abundantly. There are sound reasons for the big tile companies taking the position they do, and this discussion would carry no educational value if the points which differentiate the methods of the large and small manufacturers are overlooked.

[1] Head, Department of Ceramic Engineering, Iowa State College, Ames, Iowa.

To make an issue, we can state that the big company sells to the average consumer, while the small manufacturer deals with the unusual buyer.

The following points cover the replies which were received in answer to the questionnaire.

These statements come from the largest of the commercial firms and the replies represent a fair cross-section of opinion and reflect the situation in the tile factories as far as the interests of the Art Division are concerned.

Manufacturer, No. 1 I shall treat your request in a specific way and at the same time indirectly describe a man who is doing practically the same kind of work. The young ceramic graduate should have the following qualifications for design work:

(*a*) A working knowledge of modeling and the ability to accomplish simple modeling work, such as relief tile, etc.

(*b*) The ability to handle plaster and to make reproductive molds in a small way.

(*c*) Some art ware modeling and the reproduction of molds in actual practice.

(*d*) The ability to take a general idea and to decorate a vase in a special artistic manner.

(*e*) An appreciation of the proper blending of colors on an object.

(*f*) The ability to take colors, mix them for special shades, or adapt a specific glaze to meet a particular condition.

(*g*) The knowledge of and ability to apply decalcomanias.

(*h*) A general idea of design and the ability to produce good practical shop art drawings in the absence of an art department.

(*i*) A good fundamental education about glazes, especially the decorating colors.

(*j*) Good fundamental information about bodies.

(*k*) Working knowledge of simple mathematics.

(*l*) An absence of excessive artistic temperament.

These suggestions describe the specific characteristics of a man in this particular organization, which has the following departments to assist his work: (*a*) a modeling department composed of two men doing modeling, blocking, and casting; (*b*) a ceramic department where the basic glazes are worked out and controlled for production; and (*c*) a design department headed by a graduate of an art institute having fifteen people under his direction.

The man we have employed meets all of the requirements noted above except that he has plenty of artistic temperament.

From this description, the needs for a general utility man in ceramic art training are pointed out. Such a man is more or less able to work out problems and also to take care of emergency work. The man with this knowledge and the proper characteristics is one of the most valuable persons we have in our plant and for which there is the greatest need.

Manufacturer, No. 2 As we manufacture in our factory only commercial products and do not employ any art director or artists, we do not feel qualified to answer the questions which you have asked.

We think that the establishment of such a course is highly desirable and we hope that you will be able to carry out your plans.

Manufacturer, No. 3 You have inquired as to what training should be given to persons in order to fit them for the designing of tile. We do not clearly understand just what you wish to know. We have a drafting department

where we make our designs for the application of the finished tile, but we do not know whether you have reference to the actual production of the tile and the method of producing it by combining different materials, etc. If it is the actual designing referred to above we believe that we could give you some information that would be of interest to you. But if your question has reference only to the decorating of tile we would not be able to assist you. We could, however, refer you to persons who, no doubt, would be able to give you such information.

Manufacturer, No. 4 In reply to your letter asking our opinion as to what should be taught in the art schools of our universities with reference to the use of tile in the decoration of a home, you assume that I am fully acquainted with the work that is being done at the Ohio State University, New York State School of Clayworking and Ceramics, and the Cleveland School of Art.

I am sorry to state that I do not know what is being done at those schools and would appreciate some information as to what courses are being given there.

It strikes me further that if you would call on us we could possibly outline a plan of education from our standpoint which would be of advantage to the students and which would insure better opportunities for the students to obtain satisfactory positions after they have finished their course.

Manufacturer, No. 5 On casual thought it would seem that an art course in a ceramic institution should properly prepare students for success in plants manufacturing tile and kindred products, especially so with the technical knowledge that would be absorbed along with the training in design. It may be that this very knowledge of the limitations of clay is a handicap, for some of the most successful designers have received their preliminary training altogether apart from ceramics. Further, I am well acquainted with one manufacturer of faience and other art tile, who deliberately chooses his new designers from a school of fine or applied arts. His purpose is to secure a better blend of ideas since the older heads are in constant touch with the problems in clay.

The next seems to be a rather harsh statement, but it is true, nevertheless. If ceramic art students are anything like the majority of young ceramic engineers, they have not been trained to work for opportunity, but rather to expect opportunity and privileges to be handed to them because they feel that these have already been earned. Whereas, mechanical engineers quite to the contrary, somehow realize that their training is of advantage only as they are able to produce by it. Consequently, they jump into overalls, asking for no quarter because of schooling opportunities they have enjoyed, taking nothing for granted. They hit the ball like any other practical man determined to make good.

It may be that some of the former attitude is unconsciously absorbed by the student of ceramic art. In that predicament any individual is at a serious disadvantage and only the natural go-getter overcomes the handicap after heartbreaking disappointment and honest self-analysis.

In my opinion, a school cannot produce a person of sufficient experience to capably lead or direct designers in a manufacturing plant. At least it would not be practical for a school to do so. Such ability comes only with practical experience. A school, however, should be able to produce the finest material to build on. It is comparatively easy to criticize when one has something better to offer, but that is hardly my position at the present time. I am not in sufficiently close touch with the course in question to make intelligent recommendations, but am passing these observations on to you rather in anticipation that one who is in close touch may be able to diagnose the troubles and aid in making any desirable adjustments to educate for strength without creating weakness.

VII. TRAINING REQUIRED FOR THE WORK OF AN ARCHITECTURAL COLORIST

By Mary L. Hull

Introduction

At the Ceramic Exposition in Chicago last winter our firm exhibited some sketches showing the color schemes outlined for certain buildings. We also showed duplicates of some of the actual colored terra cotta used in those buildings and colored according to those sketches. It was at this exhibit that Arthur E. Baggs asked me to discuss the kind of training necessary to enable one to do such work.

Terra cotta is a building material much used either by itself or in conjunction with stone or brick. It has the advantage of being readily produced in ornamental shapes and in many and beautiful colors.

The employment of a colorist is a new departure in the terra cotta industry. In the past, and also at the present time, in many cases, the chemist handles the color work. For example, when I entered the service of the Midland Terra Cotta Company they had no one whose sole duty it was to look after the color. It is true that usually only two or three, or at most four, colors were put in a building. The elaborate polychrome (or many colored work) which is being more and more extensively used on buildings today, existed only in the memories of glazed brick and tile designs of the days of Assyrian, Babylonian, and Persian splendor, and similar works of art, and the exquisite work of the Della Robbias in the 15th and 16th Centuries. From the 17th Century polychrome-architectural terra cotta was little used and, indeed, did not again become popular until the present day. A new American architecture is now being developed and with it a demand for the strong, rich, luminous colors appropriate to the new designs.

Color is a dangerous thing unless correctly handled. It can make or mar the design of a building. It can be a great asset or a liability. In short, it is much like dynamite. If handled rightly it is extremely useful, but if handled badly it will completely destroy the beauty of a building. In order, therefore, for a colorist to be of value to the architect, whose design he is to handle and to the manufacturer whose material he is to handle, he must not only know just how to combine the colors in order to carry out the architect's idea, but he must also be able to visualize the appearance of the finished colored building. He must know the possibilities and limitations of the terra cotta colors with which he has to work, for the terra cotta colorist has a limited palette with which to do his painting and it is his part to combine and handle those colors so as to carry out the architect's ideas as nearly as is possible. Sometimes, to be sure, an

architect or owner will place the entire work in the colorist's hands, giving him *carte blanche* as to color.

Example of Employment

(1) As soon as an order comes into our factory a copy of it is placed on my desk. This order gives the name of the architect, owner, or contractor with whom I am to consult regarding the color scheme of the building. It also tells me where and what the building is and when the job must be ready. Sometimes a simple order will come with colors already selected through one of our salesmen, but as a rule our color department handles that part of the work.

(2) The plans for the building are studied and then I get in touch with whoever is to handle the color, and either work for him or with him as he may choose, on our problem. Usually, a sketch is made and submitted. It is, of course, necessary to know enough of architecture to understand what the architect is talking about and to be able to speak his language; otherwise all sorts of misunderstandings may arise.

It is also necessary for the colorist to confer with the chief modeler if there is any ornament in the building as it is most important that the modeling be done in a certain way if the application of polychrome is to be a success and colors and modeling are to combine in the production of a good design.

(3) The architect supplies us with an outline of the elevation or elevations, if there is more than one, and sometimes of details. These are made in black or sepia outline on white paper. It is necessary that this outline be in either black or very dark brown as any other color will affect the appearance of the colors which are to be used in painting the sketch. This is where most time should be given to the proper study of the building so that an appropriate color scheme may be used on it. When the color scheme is worked out and sketched in water colors, it is submitted to the architect for his criticism.

I have had a number of cases where the color scheme was accepted as it stood. As a rule, however, there are changes to be made. The original idea is altered or modified by architect and colorist so you see the original color sketch rarely represents the final color scheme decided on for the building. Thus, changes are made in the sketch or new sketches are made until a color scheme is worked out to the architect's satisfaction. Then the accepted sketch goes back to our factory as a guide to the actual carrying out of the work.

(4) When the colors are selected we pass them on by written order to our production laboratory where they are prepared for use. Very definite instructions in the form of colored detail blue prints and colored photographs of all ornament where more than one color is to be applied also go

to the spraying room where the colors are applied to the raw material. From the spraying room the material goes to the kilns where it is fired and from there to the fitting room where the pieces are trimmed and marked so that the men who set the terra cotta in the building may know where each piece goes and that all the pieces may fit correctly in their places. If on the fitting floor it is found that some of the coloring has turned out the way it wanted to, instead of as intended, the colorist must decide what is to be done. In short, the color department keeps in close touch with the material at various stages.

(5) After the work is in the building we look it over carefully to criticize its good points or mistakes, when they occur. If any serious complaint comes in about color it is the work of the color department to look into it and see whether replacements are necessary.

Qualifications, Training, and Experience Required

Qualifications (1) A correct eye for color, one that cannot only see colors correctly, but carry them well in the mind and differentiate fairly accurately between the various shades of the same color. Also the ability to combine colors pleasingly and in harmony with physical laws. (2) The ability to visualize, to be able to see in your own mind, how these colors will look in the building.

The person who possesses these two qualities is born with them. The ability to visualize can perhaps be cultivated, but I do not believe that anyone who is without a correct eye for color can by any amount of study develop one. This inability, according to eye experts, is due to some defect in the nervous system of the eye which interferes with the proper response to the action of the light waves. Without these two gifts highly developed in one's natural makeup it would be a mistake to choose architectural coloring as a profession.

Training Given the natural qualifications, it is first of all necessary to take a thorough art course, including line and mass drawing, painting in oils and water colors, modeling in clay, both from the cast and from life, and finally, composition. The course in anatomy is not necessary, but it will do no harm and it may do much good if you have to cope with the coloring of human figures on buildings.

And do not neglect a course in perspective. That you will need and must know. Without such work, many pitfalls will beset your path when you undertake the coloring of buildings.

The art course was named first because it is assumed that you are to be an artistic colorist, not merely a mechanical one. Then most certainly you will need some knowledge of the physics of color which is a vital part of the equipment of a colorist. That is if you are to be, in addition to an ar-

tistic colorist, what Dr. Luckiesh[1] calls a "scientific colorist." An artistic-scientific colorist is the only kind worth trying to become.

The late Walter Sargent, in the introduction to his book, The Enjoyment and Use of Color, says, "We can take up the study of color in two quite different ways; namely, as a subject in physics or as a subject in art."

The architectural colorist must use a combination of these two ways, as both physics and art must enter into his work. The colorist in any line should have at least a fairly clear understanding of the principles and laws which govern light and color. Without these he is somewhat in the position of a sailing vessel without a rudder, carried by the breeze of his impulses or inspirations, first in this direction and then in that.

You must, therefore, know not only that it is right to color a building in a certain way, but you must also know why it is right, and this you cannot know unless you are familiar with the laws that govern reflection and refraction and know something of the action of light on the optic nerve.

You must also have a clear understanding of the spectral colors and the primaries, both additive and subtractive. This you will also get in physics.

Experience Unless you are to take a position with a small concern, where you must be both chemist and colorist (which is a heavy load for one man to have to carry), ceramic chemistry is not necessary. In most companies you will have an experienced chemist with whom you can coöperate. It will be your job to supply a training and experience which his training and experience does not give him. He will supply what you lack and you will both have plenty to do without either one infringing on the other's territory. It is, however, necessary to have some knowledge of the materials with which you obtain your color and this you can get from the chemist and also by experience.

No colorist should be expected to handle the color in a terra cotta factory without being given sufficient time to familiarize himself with the colors and glazes used in that factory.

A knowledge of human nature is also necessary. You must understand people and how to get on with them. You will need it in your dealings with architects, owners, and contractors, and with the men with whom you work in the factory.

You must not only have ideas, but you must know how to sell those ideas. You must know when to yield a point and when to stand your ground. You must be able to see your co-worker's point of view and while he may learn from you, you must also be able to learn from him.

Opportunities

What positions would be open to you beside that of architectural colorist, should you follow the course of study I have just outlined?

[1] M. Luckiesh, "Color and Its Applications."

You might be successful as a salesman of any product where color plays an important part.

You should be of value to any company who needs some one to guide them in color problems regardless of what they may manufacture, if given sufficient time to familiarize yourself with their product. A year ago, a professor in one of our Chicago universities told me that he had had from various firms that year, a number of demands for colorists, and there was no one whom he felt he could recommend to them.

The work of an architectural colorist is not easy, but it is fascinating. It should not be undertaken except by those who are willing to give themselves up to concentrated and persistent work and to devote to preparation about the same amount of time and application that is required for a course in engineering.

MIDLAND TERRA COTTA COMPANY
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VIII. A STUDY OF THE CADMIUM-SELENIUM RED

BY HENRY E. MARLEY

ABSTRACT

The preparation of the cadmium-selenium red, using various sources of cadmium, sulphur, and the powdered selenium metal, is described.

Introduction

Much has been written concerning the use of selenium as a source of the red color in glass but little is to be found in the ceramic literature dealing with the preparation of that coloring material, the cadmium-selenium red.

This color is used extensively in the vitreous enameling industry to produce brilliant red enamels for kitchen utensils, signs, and stove parts. A few attempts to use it in glazes have not met with much success as the color has proved unstable at glaze temperatures which are maintained over a long period of time.

The composition of this color is usually given as cadmium, selenium, and sulphur. The cadmium may be introduced as the sulphide, oxide, or carbonate, the selenium as the powdered metal, and sulphur as the sulphur flowers. Harrison and Hartshorn[1] produced this color from mixtures of cadmium oxide, cadmium sulphide, and selenium, and also from cadmium oxide, selenium, and sulphur flowers.

In this investigation, the object was to determine the proportions of

[1] W. N. Harrison and T. D. Hartshorn, "A Preliminary Study of Ceramic Colors and Their Use in Vitreous Enamels," *Jour. Amer. Ceram. Soc.*, **10** [10], 747–60 (1927).

cadmium, sulphur, and selenium necessary for making a brilliant cadmium-selenium red and to note any peculiar characteristics of the reaction. The sources of the cadmium were to be the carbonate, oxide, and sulphide.

Preparation of the Color

Series I consisted of ten mixtures of cadmium sulphide and the powdered selenium metal, 25 parts by weight of CdS plus 1, 3, 5, 6.5, 7.5, 8, 10, 15, 20, and 25 Se, respectively.

Series II. Cadmium carbonate was the source of the cadmium in this series. The sulphur was added as sulphur flowers and selenium as the powdered selenium metal. A triaxial diagram of twenty-one members was made from three parent mixtures.

	Parts by weight
Cadmium carbonate	60–80–50
Sulphur	20–15–40
Selenium	20– 5–10

Series III. Cadmium oxide was substituted for the carbonate in this group, otherwise the mixtures were the same as in Series II. It was planned to make a complete triaxial diagram of twenty-one members as in Series II. Preliminary tests, however, gave results which were unsatisfactory and therefore only seven representative mixes were selected and prepared from this diagram.

A few trials were made using cadmium carbonate and selenium with the sulphur being omitted. The color which resulted was a dark yellow-brown in all cases and showed no tendency toward the red color.

Procedure

The ingredients were weighed out and mixed by rolling in a dry condition. The average batch weight was thirty grams. Each test was then ground in a mortar to obtain a more intimate mixture, placed in a three-inch porcelain evaporating dish and heated for ten minutes over a Bunsen burner flame. The bottom of the dish was brought to a dull redness and the contents were stirred throughout the heating period and for a short time during the cooling. In practically all the tests, some of the sulphur and selenium volatilized and sublimed in a sticky coating on the sides of the dish. The resulting color was ground fine with a mortar and pestle, placed in a glass beaker, and washed five times with hot water to remove any sulphate which had been formed during the heating. Drying was done in a small electric oven. The dried color was then ground fine in a mortar and placed in a small sample bottle.

Trials were prepared by mixing the colors with gum tragacanth and water on a glass slab and applying them with a small brush on water color board. The result produced is very close to that of the dry colors.

Series I, II, and III reacted differently to the heating process. Those mixtures containing cadmium sulphide were a dirty yellow before heating. During the heating, however, the color change was from a yellow to almost a black, and the sulphur and selenium were volatilized. The selenium collected in a black metallic film on the edges of the evaporating dish.

In Series II where the cadmium carbonate was the source of the cadmium, the raw color was gray, which on being heated turned gradually to a very dark red. The heating of these mixtures also was accompanied by the volatilization of some of the sulphur and selenium. The coating which formed on the walls of the dish was a cherry red in most cases and burned off before the end of the ten-minute heating period.

In Series III with cadmium oxide, the raw color was a dark red-brown due to the coloring influence of the cadmium oxide. In practically all these tests the powder softened and turned to a black sticky mass which was stirred with difficulty. As the temperature became higher, the whole suddenly ignited and dense clouds of sulphur and selenium were given off which sublimed in a cherry-red coating on the sides of the heating vessel. This coating had usually burned off at the end of the heating period. The material which remained was sintered and in a much harder state than that of the previous tests.

The color of the tests developed to a remarkable degree on cooling. At the end of the ten-minute heating period the colors were a very dark red which became much lighter and brighter as the cooling progressed. Those mixtures in Series II containing cadmium carbonate showed the greatest color change during cooling.

Results

In Series I where the tests were prepared from mixtures of cadmium, sulphide, and selenium, the color ranged from a dirty yellow where the selenium content was low, to brown-black where the selenium was high. Tests 5 and 6 were the best but were very dark in tone.

Series II using cadmium carbonate, selenium, and sulphur flowers produced the most brilliant reds of the investigation. Those colors in the upper part of the diagram were dark red in color while those in the lower part were toward the orange. The darkest colors developed in that portion of the diagram where the selenium content was high and the lightest shades where the sulphur content was highest. Tests 5, 8, 9, 12, 13, and 14 were the brightest of this group and varied from a deep to a yellow red.

No brilliant reds were produced in Series III by substituting cadmium oxide for the carbonate. All of the colors were of a much darker shade than those of corresponding proportions in Series II and with more or less of a brownish tone. Here again where the selenium percentage was

greatest (No. 1), the color was darkest and where the sulphur was the highest (No. 21), the color was the lightest. Test 5 gave the best red color.

Summary and Conclusions

Cadmium carbonate as a source of the cadmium in the preparation of the cadmium-selenium red produces a better color than either the oxide or sulphide.

The limits of the proportions of cadmium carbonate, sulphur, and selenium, as indicated in this study for the preparation of a brilliant red, are:

Cadmium carbonate	58–70%
Sulphur flowers	21–31%
Selenium metal	9–15%

Some form of sulphur seems essential to the formation of its red color.

Increasing the selenium in a cadmium sulphide selenium mixture tends to darken the color.

Heating in an open vessel has a tendency to dull the color by the formation of cadmium sulphate. Thorough washing with water is necessary to remove this.

Wet grinding of the ingredients in the preparation of the color should give a better product.

The possibilities for the use of this color as a coloring material in glazes should lend itself to future investigations, for a brilliant red glaze would answer a long felt want in the pottery field.

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IX. A STUDY OF TURQUOISE BLUE GLAZE

BY G. M. PETERSEN

ABSTRACT

A good turquoise blue color was obtained in an alkaline glaze at cone 1 using barium with calcium. Some further work is needed to correct crazing.

Introduction

The object of this study was to develop a turquoise blue glaze at cone 1, particularly with the use of barium. The basis of the study was the work done by Myrtle M. French[1] on turquoise glaze.

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[1] Myrtle M. French, "The Problem of a Turquoise Alkaline Glaze," *Jour. Amer. Ceram. Soc.*, **6**, 405 (1923); "Further Experiments in the Problem of Turquoise Alkaline Glaze," *ibid.*, **8**, 143 (1925).

Procedure

In the first trial a frit somewhat similar to one used by Mrs. French was prepared. It had the following composition:

$$\left.\begin{matrix} Na_2O\ 0.3 \\ K_2O\ \ 0.1 \\ CaO\ \ 0.5 \\ CuO\ \ 0.1 \end{matrix}\right\} SiO_2\ \ 2.5$$

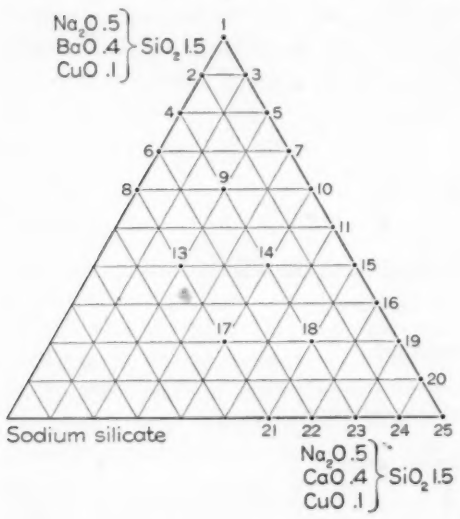
A triaxial diagram was prepared using this frit for one corner, increasing the SiO_2 to 4.5 in the second corner and adding ball clay to give 0.5 Al_2O_3 in the third corner. Some good green mats were obtained but no good blues. No further attempt was made to use the R_2O_3.

Several other trials were made but the results were not worth reporting. Two frits were next prepared with the following compositions:

$$\left.\begin{matrix} Na_2O\ 0.5 \\ BaO\ \ 0.4 \\ CuO\ \ 0.1 \end{matrix}\right\} SiO_2\ \ 1.5$$

$$\left.\begin{matrix} Na_2O\ 0.5 \\ CaO\ \ 0.4 \\ CuO\ \ 0.1 \end{matrix}\right\} SiO_2\ \ 1.5$$

These were ground for two or three hours in a ball mill. The frits had a tendency to settle out in a hard mass, so 5% of ammonium bicarbonate was added to the frit in the ball mill. This helped to keep the frit in suspension. The addition of flint in the ball mill also reduced the tendency to form a hard mass.



A triaxial diagram was prepared with the frits for two of the corners and "N" brand sodium silicate for the third. Blends were prepared with up to 40% of the sodium silicate though the higher percentages were rather hard to handle. The glazes were applied to fairly hard, white tile test pieces and fired to cone 1 in a small test kiln.

Results

Nearly all of the pieces were a good blue color except the barium corner which had a tendency toward a greenish mat in patches. This disap-

peared when the proportion of barium frit fell below 90%. All of the pieces crazed and had a tendency to run. The sodium silicate had little effect on the fired glaze.

Conclusions

Further work is needed on this glaze to correct the crazing. No attempt was made in this study to fit the glaze to any particular body but due to the persistence of the blue color it should be possible to adapt the glaze to a variety of bodies. The results obtained verify most of the work done by Mrs. French[1] except that rather large amounts of barium can be used in this glaze if used with calcium.

Acknowledgment is made to Paul E. Cox, Head of the Ceramic Engineering Department, Iowa State College, for advice and assistance in this problem.

X. A REPORT ON THE QUESTION OF INCLUDING SPECIAL TRAINING IN TERRA COTTA DESIGN IN PROFESSIONAL COURSES IN CERAMIC ART

(Submitted to the Terra Cotta Division by the Art Division)

Mr. Chairman and Members of the Terra Cotta Division:

As you know from the Program Announcement, the Art Division has made a study of the proper artistic and technical qualifications for professional designers of those ceramic products that contain some element of design. Terra cotta is such a product and consequently has been considered. These studies were undertaken primarily to determine the necessary scope of professional courses in ceramic art in order that they might fully serve the needs of the industry.

The writer has consulted, as far as limited means and time allow, with the following gentlemen: Messrs. Cret and Harbeson of the staff of the University of Pennsylvania; E. V. Eskesen and L. V. Solon of the Federal Seaboard Terra Cotta Corporation; T. F. Armstrong and E. C. Hill, of the Conkling-Armstrong Terra Cotta Company; W. F. Lockhardt of the National Terra Cotta Society, and your Chairman, S. J. McDowell. This list gives a fairly good cross-section of opinion.

The first conclusion was reached very quickly, namely, that under present conditions nearly all terra cotta design originates with the architect; the proper use of terra cotta presupposes an architectural training and it is obviously unwise to attempt to include special courses for terra cotta design in the departments of ceramic art.

That conclusion, however, does not dismiss the question as having been settled. Here is a great industry intimately connected with one of the

fine arts, architecture, in which we have been making great strides toward the development of a national form of artistic expression. In that industry most of the designing is done by someone who has had no special training in the material and processes. The questions then arise: Does that make any difference? Can a man do greater work if he knows both the limitations and possibilities of his material?

Certainly before the industrial age, the great designers actually worked in their chosen materials, and while we cannot expect the present day architect to be a skilled craftsman in each of the building materials, we may accept it as a fundamental truth that the more the average architect knows of the nature of the material and its structural and decorative possibilities and limitations, its process of manufacture and economic use, the more he will be able to make it interpret his design in a satisfactory manner.

How shall we reach the architect with his working knowledge of one of the most interesting of materials?

(1) It seems possible that, working in harmony with the Committee on Education and the Committee on Allied Arts of the American Institute of Architects and with heads of the schools offering a degree in architecture, we might introduce the following ideas:

(*a*) A brief text book covering the nature of clay, the procedure in translating a design into fired clay, its particular suitability for certain classes of work and something of its historical interest, etc.

(*b*) One or two illustrated lectures, possibly in color, showing the modern tendency of recent work of a high order that has been executed in terra cotta.

(2) In their graduating year many of the more talented students enter the competitions sponsored by the Beaux Arts Institute. It might be possible to have one of their "Projets" offered as a problem in terra cotta in which the specifications had been written by terra cotta manufacturers.

(3) Leon V. Solon has suggested a plan that would call the attention of the public and the practicing architect to the great decorative possibilities of terra cotta in a most commanding way. That is, to invite a few of our finest architects and mural decorators to submit designs for architectural details; to execute these in the terra cotta plants in small scale and to circulate them through the country on some such basis as the recent International Ceramic Exhibition. This might be done in collaboration with the American Federation of Arts or possibly the Association of Museums. If it were done so as to demonstrate the great possibilities of terra cotta as a decorative material, designed by artists of recognized ability and reputation, and did not in the least carry a flavor of an advertising scheme, I believe that it could be carried through, and undoubtedly it would be of great and lasting value to your industry.

If the Terra Cotta Division believes that the Art Division offers contacts with the various agencies outside the Society, that they would have difficulty in approaching as manufacturers, if it approves of continuing the work outlined, I would ask them to authorize their chairman to join the

Chairman of the Art Division in a request to the President of the AMERICAN CERAMIC SOCIETY to appoint one man to take the leadership in developing these plans. This man would appoint two other members of the SOCIETY to act with him.

I think that the two Divisions acting through the President of the AMERICAN CERAMIC SOCIETY would add considerable weight to the approach to outside contacts.

If it is your desire to continue with this plan I should like to suggest that the following points be brought up for discussion:

(1) The text book: the author, the chapter headings to bring out the particular points that you want to stress; the publication and expense involved, etc.
(2) The illustrated lecture: author, selection of subjects, whether it should be delivered by one man going to the schools, or whether it could be handled by sending the slides and a written lecture to be given by one of the local men.
(3) The traveling exhibition: selection of the artists to be invited; in what manner shall the artists be compensated; what plants shall execute the work; the weight and size of the collection; the selection of subjects; how it shall be circulated, and the expense.

Respectfully submitted,

E. DE F. CURTIS,
Chairman, Art Division.

XI. NOTES ON THE ANNUAL MEETING, ART DIVISION SESSIONS

Toronto, 1930

BY E. DE F. CURTIS, *Chairman*

At the Annual Meeting of the AMERICAN CERAMIC SOCIETY held at Atlanta in 1926, the question was raised as to how it might be possible to get more trained designers into the industry.

The small number present at the sessions of the Art Division recognized the question as one of great importance and worked hard on it, but entirely underestimated the complicated problems involved and tried to urge the idea that the solution would come from the present craftsmen taken into the plants. The idea was basically wrong and the confidence of the industrial men was still lacking.

At Detroit, in 1927, we thought that if we explained the situation the factory men would respond with the necessary information and make some effort to meet us half way.

We tried that at Atlantic City and found no reaction at all, but meanwhile had learned a good deal ourselves as to the preliminary work that had to be done before we could hope for results. We also found out that eventually it would be through the Art Division that any real attempt must be made to improve our standards.

The projected first International Ceramic Exhibition encouraged us to keep on. In the meanwhile we surveyed the instruction that was being offered in ceramic art and found that aside from the New York State School of Clayworking and Ceramics there was very little serious effort being made to teach both the technical side and the artistic, and that there was even little real contact there with the producing plants except from the engineering point of view.

There was no call for such instruction and no positions were open for graduates, this in spite of the fact that a considerable part of the industrial products were dependent on artistic quality for sales.

In the meantime, Ohio State University and the University of Cincinnati had offered courses in professional work in ceramic art. It seemed wrong that these two schools should develop along the lines of studio potters, teacher's training, and general ceramic interest if it were possible to outline the real importance of design as applied to producing plants.

The International Ceramic Exhibition had by this time showed us the results that might be obtained where artists trained for plant work had coöperated as they had in foreign ware; it had stimulated a great deal of interest both in the industry and the public and it seemed like a most opportune time to see what could be done.

The Chicago Meeting was used to see if some of the industrial men were at all aware of the situation; that we were in danger of losing a large market to foreign plants and that design played a fairly important part in holding it. There seemed to be a strong undercurrent of interest but a most pessimistic view of the value of the Art Division in this field. Three immediate problems seemed to be in sight.

(1) We ourselves, must understand the real problems of coördinating artistic and technical education with factory conditions and economics.
(2) To present the results in such a way that the industries would see the value of carrying it on themselves.
(3) To add whatever weight and prestige we could to our own point of view.

The Chairman of the Art Division has tried to accomplish these aims through the Report to the Trustees on the extension of activities of the Art Division, which was condensed in the Toronto program as follows:

Shortly after the last Annual Meeting of the Society (Chicago), the Chairman of the Art Division called the attention of the Trustees to the fact that there is urgent need for research work looking toward close co-

operation between schools of design, especially those offering professional courses in ceramic art, and the producing plants. The United States is producing brilliant designers in some lines of industrial work but few of them are finding their way into ceramic plants. Much of our ceramic production depends to some extent on artistic design for its appeal to the public, but a very small part of that design is supplied by men especially trained for the work.

The Trustees approved the Report submitted by the Chairman of the Division, invited certain school instructors and plant executives to participate in an investigation to determine the proper technical and artistic qualifications of the industrial ceramic designers. The work has proceeded along these lines by means of conferences, correspondence, and plant studies.

The program of the Art Division at this Meeting is being devoted to the reports of the committee leaders and to a discussion of the plans recommended by them as to the best means of enabling the schools of design to function effectively in the commercial field.

The Art Division earnestly urges the attendance of the industrial men at these conferences; their interest is essential to the success of any movement, to stimulate interest in industrial ceramic design.

The expense of the preliminary investigation was shared by the schools and the SOCIETY.

The grant to Ohio State University of $4000 per year for two years by the General Education Board, for the creation of a scholarship in ceramic design applied to tableware, with provision for research as to technical and market requirements, created a great deal of interest in and respect for the ability of the Art Division to offer constructive help. With all due credit for the hard work of the committeemen and leaders, I am sure that it was this announcement coming from the General Education Board that has laid a solid foundation for substantial improvement in ceramic art in the United States.

Before the Toronto Meeting, the Art Division was thought of as a pleasant unimportant appendage to the SOCIETY with hardly a dozen really active workers.

Now there are forty or fifty persons taking some part in its affairs; it has become a vital part of the SOCIETY and I think that we may state that the quality of work is on a par with that of the technical divisions.

Arthur E. Baggs, Ohio State University, read his report on design problems on the tableware industry, proving conclusively that he has a fine understanding of the situation and that the grant by the General Education Board will be ably directed. The paper and discussion lasted nearly the full three-hour period.

Charles Sebring spoke at some length on his experiences in developing

original designs, as did also the chief designer of the Onondaga Pottery. Paul E. Cox, Iowa State College, Edward Schramm, Onondaga Pottery, Charles F. Binns, N. Y. State School of Clayworking and Ceramics, and H. S. Kirk, Newark Museum contributed to the discussion and the following points were emphasized: (1) There is great need for improved design in tableware, (2) present sources are not sufficient, (3) copying successful designs is detrimental to the industry, and (4) there is a really wide interest among the producing plants in the successful operation of the grant to Ohio State University and we may confidently expect tangible assistance from them.

H. S. Nash, University of Cincinnati, read his paper on "The Place of Design as a Merchandising Factor in Glassware Industry." This was an unusually able presentation of the situation and brought home to us the weakness in the structure and operation of the Division.

There were no glassware manufacturers present to hear the paper. This situation we hope to correct during the year and we feel sure that the efforts of Professor Nash will be brought to the attention of those who probably would be most interested. Professor Nash made his points clear to us: that there are great possibilities in glass and the decorative field, that better designers are needed, and that there is little apparent interest on the part of the manufacturers.

Further study is most important. He offers a practical suggestion for the formation of a group to stimulate interest.

Mrs. Myrtle M. French, Art Institute of Chicago, in her paper on "Art Pottery" establishes the fact that industrial designers need special training, that direct coöperation between the plants employing designers and schools of design teaching ceramics is possible on a part time basis and is advantageous. No special courses for professional work were advocated. More consideration should be given this subject as it is one that is least affected by mass production considerations and is much larger in volume than is supposed. There seems to be some disposition at the New York State School of Clayworking and Ceramics to concentrate on this development.

Paul E. Cox, head of the Department of Ceramic Engineering, Iowa State College, read his report on "Tile and Sanitary Ware." Sanitary ware seems to be an engineering problem as far as shapes are concerned. The largest part of tile and fixture design is planned by the advertising departments of the large plumbing manufacturers, and it is clear that no special training should be attempted for design in sanitary ware.

A good description of the kind of designer needed was brought out by one answer from a tile plant that employed such a man, but it is not yet clear if the scope of the work would warrant any special training aside from that given in general. Probably a good many of these designers will come

through the design studios now maintained by the plants, with some extension help from the schools. It is a most important part of our architectural development and much may be done with it in connection with terra cotta this year.

Mr. Suter, American Encaustic Tiling Company, offered a most helpful paper showing clearly that the art spirit still exists in the factory.

E. de F. Curtis, Pennsylvania Museum's School of Industrial Art, read his paper to the joint session of the Art and Terra Cotta Divisions.

The report was adopted and under the instruction from the two Divisions, S. J. McDowell, Corning Terra Cotta Company, the outgoing chairman, and the incoming chairman, H. D. Callahan, Northwestern Terra Cotta Company, and the Chairman of the Art Division, held a conference with Edward Orton, Jr., the new president of the SOCIETY.

The situation was outlined to General Orton and he was asked to appoint Leon V. Solon, Federal Seaboard Terra Cotta Company, to act in advancing the propositions, namely, (1) to introduce some form of instruction in ceramics in the architectural schools, (2) to see what can be done toward the preparation of a text book for architectural students, (3) to see if it is possible to have the Beaux Arts Institute use a ceramic problem as one of their projects, and to carry on the idea of a traveling exhibition of terra cotta, and perhaps tile.

General Orton was greatly interested in the possibilities and agreed to give the matter his careful consideration.

Much remains to be done. Next year the Meeting is to be held in Cleveland and the SOCIETY has voted to sponsor a great ceramic show. The Chairman of the Local Committee in charge has advised that the Cleveland Auditorium has been secured and that the show will be built up around the art interest and that all Cleveland is anxious for it to be a great success. This fact in connection with the proposed exhibition for the tile and terra cotta programs might prove to be far-reaching in results.

The problems in glass and decorative ceramics must be brought nearer to some solution.

We must plan for the next Meeting so that we shall not have the right papers presented to the wrong group.

We must adopt the policy to bring the younger crowd to the Meetings.

It is not planned to carry on permanently such a large program. It is hoped that the industries, the schools, and the public will, after a few years, carry it on themselves. In the meantime, there is no other disinterested organization able to see the need of the work and we must assume this leadership to the best of our ability.

XII. REPORT OF THE CHAIRMAN, ART DIVISION, AMERICAN CERAMIC SOCIETY

By E. de F. Curtis

If we are to develop the Art Division to its point of greatest usefulness we must realize the wide scope of its interests. We must formulate a clearly defined program and provide an organization within the Division which will allow us to carry the program forward without throwing the whole responsibility onto a few workers.

With these points in mind the following recommendations are presented:

Policy The Art Division of the American Ceramic Society is interested in any group or movement that is concerned with the manufacture, use, and appreciation of those ceramic products that contain an element of artistic design.

To provide an organization based on this policy we must arrange for contacts with the Society, the educational field, individual workers, manufacturing plants, selling agencies, and the public.

Such an organization is suggested as follows:

Board of Trustees, American Ceramic Society
Art Division Trustee, E. de F. Curtis
Chairman, Art Division
Secretary, Art Division M. M. French

Councilor for Society Activities, Paul E. Cox
- Research, Paul E. Cox
- Rules, Martha G. Westfeldt
- Membership, Charles Harder
- Nominations { T. Lenchner, E. de F. Curtis
- Exhibition { M. L. Fosdick, M. M. French
- Education (Councilor), A. E. Baggs
- Program (Councilor and Officers)
- Papers, M. L. Fosdick
- Financial (Trustee), E. de F. Curtis

Councilor for Industrial Relations, Charles R. Richards
- Terra cotta, L. V. Solon
- Tableware { Chas. Sebring, Col. Heckman
- Glassware, H. S. Nash
- Enamel, No appointment
- Sanitary ware, No appointement
- Decorative ceramics, Chas. F. Binns
- Tile, Walter P. Suter

Councilor for Educational Interests, A. E. Baggs
- Professional, A. E. Baggs
- Teacher training, E. de F. Curtis
- Grade School, Mrs. Openhym
- Courses for appreciation, Ruth Canfield
- Bibliography, Ruth Whitford

Councilor for Outside Contacts, M. G. Shearer
- Museums, H. S. Kirk
- American Federation of Arts, M. G. Westfeldt
- General Federation of Women's Clubs, Ruth Canfield
- American Institute of Architects, L. V. Solon
- Publicity, Theodore Lenchner

Councilor for Craftsmen, Walter P. Suter
- Tools, Sales problems { Robert Bacher
- Training, Charles Harder

Since the above plan was adopted at the business meeting of the Art Division at Toronto the appointments for the year have been noted.

The officers and councilors shall determine the work of the Division for

the year. The Councilors shall outline the special studies to be made during the year and the committeemen shall be responsible for carrying them forward.

At the Annual Meeting the reports and recommendations of the Councilors shall be presented and discussed and papers of especial value shall be read. Papers presented by Art Division members of particular interest to other Divisions shall be offered to the Chairmen of the other Divisions.

The remainder of the Art Division program should be composed of papers and illustrated talks of general interest and every effort should be made to concentrate on the exhibition of ceramic work by industrial plants, individuals, and students.

It would be much better for the Division if the Nominating Committee would first ascertain if the candidates will serve if elected, and if the election were then held by letter ballot. The new officers should assume their duties on the second day of the Annual Meeting. Past officers should become councilors. Since the necessity for such a wide spread program may not be apparent I wish to indicate how each committeeman can help the general aims of the Division. All committeemen shall be members of the SOCIETY committee of the same name.

Research Monographs on technical problems of color, texture, and processes as related to artistic developments are urgently needed by the Division. These might be used as theses in undergraduate work. Research work to establish principles of pure design as applied to ceramics more definitely is also indicated.

Rules, Nominations, and Educational Only to function with SOCIETY Committees.

Membership Every corporation manufacturing an artistic product should have a representative in the Art Division as well as a technical Division. We should also have some representation of architects, teachers, and connoisseurs in the Division. To strengthen the Division in this way we should consider the possibilities of an illustrated annual proceedings number of the Art Division activities.

Exhibitions It should be the aim of the Division to present each year for the SOCIETY and the public, a picture of the progress of the art. Groups of industrial work, tableware, and glass, decorative ceramics of all kinds, the work of individuals, and student work should be shown under proper conditions.

Programs It is obviously impossible to crowd all these activities into a few hours at the Annual Meeting. The general work for the year should be planned at the Meeting, the work kept up throughout the year by the committeemen, and conclusions and discussions only considered at the Meeting.

Papers If the above plan were adopted the papers committeeman would only have to arrange for an orderly presentation.

Financial Funds for the Annual Exhibition, for scholarships, and for special activities will soon become important.

Industrial Relations

Terra Cotta This project is covered in a separate paper at this meeting and as indicated will be carried on by Mr. Solon.

Tableware This Committee will work directly with Ohio State University to help insure the success of the General Education Board grant. No further activities are planned by the Division at present.

Glassware This committee will make special effort to interest producing plants to consider where and to what extent special instruction in design should be provided and to carry out suggestions outlined in the paper presented at this Meeting.

Enamel and Sanitary Wares No work under consideration at this time.

Tile Coöperate with terra cotta plans for architectural student instruction, Beaux Arts Institut Projets and Ceramic Art Exhibition.

Decorative Ceramics A further consideration of the extent of the field with recommendations for special courses.

Educational Field

Professional Work A report on the possible necessary extension of ceramic art in the next few years will be necessary to provide post graduate courses to prepare for professional teaching.

Grade School Work Monograph on a simple adequate course to lead to an appreciative understanding of ceramic processes, fitness of design including an inexpensive equipment, and the possibilities of extension through state school boards.

Appreciation Work Courses to be offered in connection with exhibitions and fine arts studies leading to a better understanding of contemporary work.

Bibliography Report on the necessity of a bibliography of ceramic art, probable cost, suggested method of approach, *i.e.*, by abstracts of volumes, or references to subjects.

Teachers Training A monograph of laboratory exercises, required reading, and time requirements to prepare for grade school teaching, an important link in building up an appreciative public.

Outside Contacts

Museums We should publish a list of particularly fine and important pieces and their location in the United States. I suggest that we offer the Association of Museums reprints of Fred Rhead's article on the decorative processes and see if the Museums would consider an AMERICAN CERAMIC SOCIETY mark to identify pieces as to type and period, etc., for study.

American Federation of Arts They have several traveling exhibitions of pottery on tour. Could we arrange one with them to show special principles and route it to the industrial plants? They have had a man in Europe studying foreign methods and industrial conditions; is this information available to the SOCIETY?

General Federation of Women's Clubs They also circulate pottery exhibitions and exert a strong influence for building up interest in contemporary work.

American Institute of Architects A report of the possibility of coöperating with their committees on allied arts, crafts, and education.

Publicity A report on the possibility of working agreement with trade journals and current magazines.

Craftsmen The First International Ceramic Exhibition showed that the American craftsmen were at a disadvantage from working at lower temperatures. Tools, special training, and some sales plan and outlets are needed. The encouragement of the individual worker is most important.

Conclusion

With the end in view of stimulating interest in the manufacture, use, and appreciation of artistic ceramic products the Art Division would like to present this picture of the situation as it stands today under separate cover, since much of it is of a nature that does not belong in the technical *Journal* and it would not reach the proper audience unless printed at one time.

XIII. BIBLIOGRAPHY OF PAPERS APPEARING IN THE TRANSACTIONS, JOURNAL, AND BULLETIN OF THE AMERICAN CERAMIC SOCIETY WHICH ARE CONCERNED WITH LOW TEMPERATURE WORK AND ARE OF INTEREST TO MEMBERS OF THE ART DIVISION

COMPILED BY MARION L. FOSDICK

There were nineteen volumes of the *Transactions of the American Ceramic Society* after which the name was changed to the *Journal of the American Ceramic Society*, a monthly publication. The *Journal* volumes are now in their 13th year. The *Bulletin of the American Ceramic Society* is published under the *Journal* cover, but is paged separately with independent volume numbers and index.

The Manual of Ceramic Calculations submitted by the Committee on Equivalent Weights is to be found in Volume II, *Transactions*, pages 197 to 279.

The collection of Standard Definitions, Specifications, Tests, and Descriptions of Apparatus submitted by the Committee on Standards is to be found in the *Journal*, **11**, [6], 335–535 (1928).

The Bibliography is arranged alphabetically according to the subject matter. The title of the article follows, with author name, whether in *Journal* or *Transactions*, volume number, issue number (in case of the *Journal* reference) page number, and year. The abbreviations *Trans.*, *Jour.*, and *Bull.*, are used for the three respective publications.

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